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FRUIT LABORATORY

In-Depth Program Review

April 13-16, 2004

Building 005, Room 020

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CATALOGING PREP

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Table of Contents

(Continued on next page)

PROGRAM

NTRODUCTORY INFORMATION

RIS PROJECTS & FUTURE PLANS

FINANCIAL

ADMINISTRATIVE ISSUES

SCIENTISTS' CONTRIBUTIONS

Agenda

Tuesday, April 13, 2004 - Building 005, Room 21

8:00- 8:30 a.m.	Review Team meets for discussion
8:30- 9:30	**Executive Session I.** Charge to the Review Team Beltsville Area Office, National Program Staff, Plant Sciences Institute
9:30- 9:45	BREAK
9:45- 10:05	**FL Overview:** *Freddi A. Hammerschlag, Research Leader*
10:05-10:20	**Program Review:** Enhancement of Small Fruit Germplasm Through Genomic Characterization and Genetic Improvement with Emphasis on Disease Resistance (1275-21220-181-00D) *Lead Scientist: Mark K. Ehlenfeldt*
10:20-10:35	**Program Review:** Enhancement of Blueberry and Strawberry Through Analysis and Modification of the Plant Genome (1275-21000-157-00D) *Lead Scientist: Lisa J. Rowland*
10:35-10:50	**Program Review:** Physiology of Strawberry, Blueberry, and Other Small Fruit Crops in Sustainable Production Systems (1275-21000-175-00D) *Lead Scientist: Brent L. Black*
10:50-11:05	BREAK
11:05-11:20	**Program Review:** The Role(s) of Heat Shock Proteins in the Response of Small Fruit Crops to Elevated Temperature (1275-21000-160-00D) *Lead Scientist: Janet Slovin*

11:20-11:35	**Program Review:** Molecular Approaches to Exotic Fruit Crop Diseases with Emphasis on *Xanthomonas*, *Xylella* and *Citrus* (1275-21000-204-00D)
	Lead Scientist: John S. Hartung
11:35-11:50	**Program Review:** Federal Quarantine for the Importation of Plant Genetic Resources (1275-21220-186-00D)
	Lead Scientist: Gary R. Kinard
11:50-12:00	**Program Review:** Federal Quarantine for the International and Domestic Movement of *Saccharum* (Sugarcane) Genetic Resources (1275-21000-163-00D)
	Lead Scientist: Suzanne S. Hurtt
12:00-12:30	Question/Answer Session
12:30- 1:30 p.m.	LUNCH
1:30- 2:30	**Executive Session II.** Review Team meets with Invited Guests
2:30- 4:00	Tour of Beltsville West and East Facilities
4:00- 5:00	Working Session

<u>Wednesday, April 14, 2004 - Building 010A, Room 200</u>

Review Team interviews with scientists, Building 010A, Room 200

8:00- 8:40 a.m.	Brent L. Black
8:40- 9:20	Mark K. Ehlenfeldt
9:20-10:00	James J. Polashock
10:00-10:15	BREAK
10:15-10:55	Kim S. Lewers
10:55-11:35	Lisa J. Rowland

11:35-12:15	Janet P. Slovin
12:15- 1:15 p.m.	LUNCH
1:15- 1:55	Shiow Y. Wang
1:55- 2:35	John S. Hartung
2:35- 3:15	Post-doctoral and visiting scientists
3:15- 3:30	BREAK
3:30- 4:10	Support staff from Beltsville-West
4:10- 5:00	Working Session

Thursday, April 15, 2004 - Building 580 Conference Room and 010A, Room 200

Review Team interviews with scientists and support staff, Building 580, APHIS Conference Rm

8:15- 8:35 a.m.	Transfer to Building 580, APHIS Conference Room
8:35- 9:15	Suzanne S. Hurtt
9:15- 9:55	Gary R. Kinard
9:55-10:10	BREAK
10:10-10:50	Ray Mock
10:50-11:30	Ruhui Li
11:30-12:10	Steven A. King
12:10- 1:10 p.m.	LUNCH
1:10- 1:50	Support Staff from Beltsville- East
1:50- 2:10	Transfer to Building 010A
2:10- 2:25	BREAK

2:25- 3:05	Freddi A. Hammerschlag
3:05- 5:00	Working Session - Preparation of Draft Report

Friday, April 16, 2004 - Building 010A, Room 200

8:00- 9:00	Working Session
9:00-10:00	**Executive Session III.** Review Team meets with Beltsville Area Office, National Program Staff, Plant Sciences Institute
10:00-10:15	BREAK
10:15-11:15	Review Team meets with all FL scientists and support staff

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Cornell University
Ithaca, NY

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Introduction

The Fruit Laboratory, as presently constituted, dates to the ARS reorganization in 1972 when the Beltsville scientists, formerly in the Small Fruit and Grape, Pome Fruit, and Stone Fruit Investigations, were combined to form the new Laboratory under the leadership of Dr. D. H. Scott. Dr. Scott stepped down later that year and was replaced by Dr. Miklos Faust who served as Research Leader for almost 20 years.

The antecedents of the small fruit research in the Fruit Laboratory go back long before 1972. Strawberry breeding research was started at Glenn Dale, MD, in 1920, by Dr. George Darrow, although a few strawberry crosses had been made there even earlier by Dr. Walter Van Fleet, a USDA rose and chestnut breeder. This program was moved to Beltsville in 1932. Dr. Frederick Coville began blueberry research on the Mall in Washington, DC, in 1906 with the first hybridizations done in 1911. This program was later moved to the Arlington Farm in Virginia and then to Beltsville about 1934. The blueberry breeding program was moved from Beltsville to Chatsworth, New Jersey, in 1989. In late 1995, the Chatsworth unit was made a work site of the Fruit Laboratory, thus reuniting these research programs.

Tree fruit breeding and disease research was moved from the Fruit Laboratory to the Appalachian Fruit Research Station, Kearneysville, WV, when that station opened in 1979. Scientist retirements and relocations further reduced the tree fruit research effort and the remaining tree fruit scientists began redirecting their efforts to small fruits starting in 1991. This redirection is now complete.

One aspect of the tree fruit disease research was on bacterial diseases, especially those incited by *Xanthomonas*. When a serious outbreak of citrus canker, incited by a different *Xanthomonas* species, occurred in Florida in the early 1980's, Dr. E. Civerolo began work on this citrus disease. This effort has grown into the current program on exotic diseases of citrus, which is unique and widely used by visiting scientists from throughout the world.

Indexing of imported germplasm started with stone fruits in 1958 at the Plant Introduction Station in Glenn Dale, MD, and was expanded to include pome fruits in 1964. In 1972, the Animal and Plant Health Inspection Service (APHIS) was separated from ARS, the parent agency, and much of the quarantine testing went with APHIS. When APHIS constructed Building 580 at ARS's Beltsville Agricultural Research Center in the mid-1980's, the two agencies agreed that ARS would be responsible for all future quarantine testing and APHIS would provide the facilities. This testing was done by the Plant Quarantine Laboratory (PQL), located at both Glenn Dale and Building 580. In 1990, PQL was merged into the National Germplasm Resources Laboratory (NGRL) and the former PQL became the Plant Germplasm Quarantine Office (PGQO). In 1997, PGQO was transferred to the Fruit Laboratory. Starting in 1989, PGQO began moving out of Glenn Dale to the Building 580 site and the move of the field operations was completed in 1999.

The diverse nature and wide-spread locations of the Fruit Laboratory provides opportunities as well as challenges. Another challenge has come from the retirement of five scientists between 1999 and 2002, the addition of a new scientist following the Beltsville Area Reorganization of 2000, the loss of one scientist to the University of Minnesota in 2001, and the probability of several additional retirements in the next one to four years. The addition of five new scientists since 1999 has enabled the Fruit Laboratory to move into new directions and to restructure several Laboratory programs. The recruitment for a new Small Fruit Plant Pathologist and replacements for additional planned retirements over the next several years will also lead to new opportunities.

Most of the current staff conducts multi-disciplinary research to solve problems in the production of small fruits, primarily strawberry, blueberry, and brambles, as well as conduct basic molecular studies on gene markers and gene mapping that will ultimately impact the breeding programs. Demand for high quality small fruit will stay high in the future as their important role in human health becomes more publicized. Additional opportunities exist for introduction of new small fruit crops that have noteworthy attributes.

A second major emphasis in the Laboratory is the characterization at the molecular level of exotic diseases of citrus and development of diagnostic procedures for early detection of these diseases. This program will continue to be critically important as new diseases begin to threaten the citrus industry.

The third major emphasis of the Laboratory is processing of prohibited germplasm through quarantine and the development of improved molecular detection methods for numerous disease organisms that are of quarantine concern in the U.S. Importation of prohibited germplasm will remain a critical need for plant breeding programs and repositories throughout the country and the PGQO will continue to play a vital role in making this germplasm available.

Mission Statements

Fruit Laboratory

The overall mission of the Fruit Laboratory is enhancement of small fruit germplasm, improvement of fruit production, characterization and development of diagnostic procedures for exotic diseases of citrus, and processing of restricted plant germplasm through legally required pathogen testing protocols while in quarantine. This mission is based on development of basic information about physiological, biochemical, genetic, pathogenic, and molecular genetic factors affecting fruit production. Current research involves: (1) developing flavorful, large-fruited disease resistant cultivars through breeding and molecular methods, (2) developing and implementing molecular genetic methods for locating, mapping and inserting genes of interest in small fruit crops; (3) developing sustainable cultural systems for small fruit crops; (4) developing basic information about the properties and infection processes of plant pathogens of small fruits, citrus and temperate zone fruit trees, methods of detection, and phylogenetic relationships among pathogens affecting citrus and temperate zone fruit trees; and (5) processing prohibited genera of imported plants through quarantine by testing for pathogens such as viruses, viroids, and phytoplasmas.

Plant Sciences Institute

The Plant Sciences Institute's research mission is to develop biological, chemical, and physical processes and principles including bioregulation that will improve pest management systems, improve crop quality, support regulatory and action agencies, respond to research needs identified by farmers and other "customers," and contribute to advances in biotechnology and other societal benefits. The Institute's mission is accomplished through complex and exceptionally difficult fundamental and applied research programs in 13 laboratories.

Agricultural Research Service

ARS conducts research to develop and transfer solutions to agricultural problems of high national priority and provide information access and dissemination to: ensure high-quality, safe food, and other agricultural products, assess the nutritional needs of Americans, sustain a competitive agricultural economy, enhance the natural resource base and the environment, and provide economic opportunities for rural citizens, communities, and society as a whole.

Research, Education and Economics

The Research, Education and Economics (REE) area of USDA is dedicated to the creation of a safe, sustainable, competitive U.S. food and fiber system and strong, healthy communities, families, and youth through integrated research, analysis and education.

Research Accomplishments In Brief

Small Fruit Breeding

'Hannah's Choice' and 'Cara's Choice' blueberries were selected and released. (Ehlenfeldt)

Blueberry clones with superior fruit firmness were identified and incorporated into the breeding program. (Ehlenfeldt)

Blueberry cultivars with superior levels of antioxidants were identified. (Prior and Ehlenfeldt)

Cold hardiness and deacclimation was evaluated in a diverse range of blueberry genetic materials. (Rowland and Ehlenfeldt)

Cold hardy *V. constablaei* - *V. ashei* hybrids were selected. (Ehlenfeldt and Rowland)

Differences in deacclimation rate were found among various blueberry genotypes that can be exploited to breed more spring-frost tolerant cultivars (Rowland and Ehlenfeldt)

'Messabi', 'Ovation', and 'Winona' strawberry cultivars were released since 1999. 'Ovation' is an exceptionally late-season cultivar that produces large attractive fruit. 'Messabi' and 'Winona' resulted from collaboration with the University of Minnesota to develop *Phytophthora fragariae* (red stele) resistant cultivars for Minnesota and surrounding regions. (Galletta, Hokanson, Maas, Lewers)

US 4808 and US 4809 germplasm releases are resistant to *Xanthomons fragariae* (bacterial angular leafspot), were distributed to public and private strawberry breeders across the country, and will become the core of the *X. fragariae* resistance breeding efforts for the nation. (Maas, Hartung, Hokanson, Galletta)

Small Fruit Diseases and Pests

Blueberry cultivars resistant to *Botryosphaeria dothidea* and *Phomopis vaccinii* were identified using a detached stem assay screen of 100 cultivars. (Polashock)

Anthracnose fruit rot susceptibility/resistance was determined for more than 100 blueberry cultivars with diverse genetic backgrounds (Polashock and Ehlenfeldt)

A cDNA-AFLP procedure was developed for *Vaccinium* spp. to identify flower-specific genes associated with mummy berry fruit rot resistance. (Polashock)

Cranberries were produced with much higher glucosylated anthocyanins (for better bioavailability of antioxidants) through interspecific hybridization. (Polashock)

A sensitive detection system was developed for blueberry Red Ringspot virus. (Polashock)

Blueberry cultivars and wild species material resistant to mummy berry blight and mummy berry fruit rot were identified and selected as parental material for the breeding program. (Ehlenfeldt and Stretch)

Blueberry clones with superior resistance to anthracnose fruit-rot were identified and incorporated into the breeding program. (Ehlenfeldt, Polashock, and Stretch)

Comparative foliar and fruit responses to infection by anthracnose (*Colletotrichum acutatum*) was evaluated for the possibility of using leaf assays for anthracnose fruit-rot resistance testing. (Ehlenfeldt and Stretch)

Strawberry resistance to *X. fragariae* was found to show an inheritance pattern consistent with control by recessive alleles at three to four loci. (Maas, Hartung, Hokanson, Lewers)

Strawberry germplasm accessions resistant to five isolates of three *Colletotrichum* species have been identified. (Maas, Hokanson, Smith, Hancock, Serce, Lewers)

Biotechnology/Molecular Biology of Small Fruit Crops

Genetic linkage maps based on RAPD and EST-PCR markers were developed for two testcross populations of blueberry that segregate for chilling requirement and cold hardiness and one QTL associated with cold hardiness was identified in the diploid *V. corymbosum* testcross population. (Rowland)

Established that inheritance of cold hardiness in blueberry can be explained by a simple additive/dominance model of gene action. (Rowland)

Several members of the dehydrin gene family of blueberry were isolated, sequenced, and used for expression studies in whole plants and cell suspension cultures. (Rowland)

RAPD and AFLP markers were used to generate DNA fingerprints of major strawberry cultivars. (Rowland)

The first publicly available EST database comprised of ~1300 ESTs was developed for blueberry. Sequences were used to identify new cold acclimation-responsive genes in blueberry and to develop EST-PCR markers for DNA fingerprinting and mapping in blueberry. (Rowland and Slovin)

EST-PCR markers were used to generate DNA fingerprints of major blueberry cultivars and tested for their ability to amplify DNA fragments in related *Ericaceae*, cranberry and rhododendron. (Rowland and Polashock)

An inbred line of the diploid strawberry *Fragaria vesca* was developed for evaluating the role of genes in all aspects of plant growth and development and the role of specific genes in response to abiotic and biotic stress using transformation and mutagenesis. (Slovin)

Sequence data for several heat shock protein genes and transcription factors, as well as genes involved in the regulation of flowering have been obtained for the diploid strawberry *Fragaria vesca*. (Slovin)

SSR markers were developed for strawberry from genomic clones of 'Earliglow' DNA and from *Fragaria* EST sequences archived in GenBank. Over 90% all SSRs developed from a genomic or EST sequence from any *Fragaria* genotype will amplify a product from a member of any other *Fragaria* species. About 20% to 30% also amplify a product in a member of the *Rubus* genus (Hokanson, Styan, Cregan, Lewers).

SSR markers were used with two populations of the octoploid paternal progenitor, *F. virginiana*, of octoploid cultivated strawberry, *F.* × *ananassa*, to show that *F. virginiana* chromosomes pair at meiosis like those of a diploid species. The implication is that commercial strawberry also behaves like a diploid and movement of desired genes from wild to domestic strawberry will be simpler than earlier expected. (Hokanson, Styan, Ashley, Ashman, Lewers)

Protocols for high frequency gene delivery and shoot regeneration have been developed for several commercially important blueberry cultivars including 'Bluecrop'. (Hammerschlag)

Tissue-culture screening system was developed to evaluate strawberry germplasm for resistance to *Colletotrichum acutatum* (anthracnose) (Hammerschlag)

Identified several tissue-culture induced strawberry variants with increased levels of resistance to *Colletotrichum acutatum*. (Hammerschlag)

Established that the antimicrobial peptides cecropin, α-thionin DB4 and γ-thionin RsAFP1 are highly toxic to the strawberry pathogen *Xanthomonas fragariae* (bacterial angular leafspot disease) and thus introducing eitherof these genes into strawberry may be useful for controlling this disease. (Hammerschlag)

New vectors were constructed for high-level gene expression in blueberry and scorch virus resistance in blueberry. (Polashock)

Small Fruit Crop Sustainable Production Systems

Based on yield and fruit quality data, established that the advanced matted row system provides growers with a reduced-input system for strawberry production in the mid-Atlantic and Northeastern United States. (Black, Enns, Hokanson)

Determined that blueberry plants grew as well and yielded as much fruit in two coal ash-compost mixtures as plants grown in soil typical of commercial blueberry plantings. This provides a basis for developing a cultural system using very low cost industrial, municipal, and agricultural by-products that would allow production near population centers without regard to the existing soil types. (Zimmerman, Black)

With cooperators from the University of Maryland, preplant treatments were tested for alleviating replant disorder in raspberry. Compost amendment was more effective than Sudex-Brassica or Corn-Barley crop rotations for improving survival and establishment of ten raspberry cultivars. (Black, Zimmerman)

Demonstrated that Prohexadione-Calcium, a gibberellin synthesis inhibitor, is effective in reducing fall runnering and increasing branch crown formation of 'Chandler' strawberry in a cold-climate production system. (Black)

Identified *Elaeagnus umbellata* (Autumn olive) fruit as a good source of lycopene, generating interest in this plant for phytonutrient research, and as a potential alternative crop. (Fordham, Black, Clevidence, Zimmerman)

Established that strawberry cultivars and selections, grown in the annual hill plasticulture system produced fruit with higher soluble solids content, total sugar, fructose, glucose, ascorbic acid, titratable acid, citric acid, flavonoids, and antioxidant capacities than those grown in the conventional matted row system at Beltsville, Maryland. (Wang, Galletta)

Established that berry fruits have high scavenging capacity of active oxygen species such as pyroxyl radicals, superoxide radicals, hydrogen peroxide, hydroxyl radicals, and singlet oxygen. The oxygen radical scavenging enzyme activities are correlated to antioxidant capacities in berry fruits. (Wang)

Demonstrated that genotype, maturity, growth and storage temperatures, and cultural conditions affect antioxidant capacity in berry crops. (Wang).

Compost as a soil supplement enhanced plant growth, fruit quality, level of antioxidant compounds and oxygen radical absorbing capacity in strawberries. (Wang)

Demonstrated that preharvest application of methyl jasmonate reduced water stress in strawberry plants and increased fruit quality, phytonutrient content and antioxidant activity in raspberries. (Wang).

Elevated atmospheric CO-2 concentration resulted in increases in antioxidant and aroma compounds in strawberries. A positive relationship existed between antioxidant values and anthocyanins or phenolic content (Wang, Bunce, Maas)

Collaborative research with CDC, NIOSH scientists showed that bioactive compounds isolated from blackberry fruit possess anti-skin cancer properties. (Wang)

Citrus Diseases

With collaborators in Brazil, determined that the citrus leafminer, *Phyllocnistis citrella* is not capable of transmitting citrus canker bacteria from tree to tree. This clarifies the epidemiology of citrus bacterial canker disease, which is nonetheless exacerbated by the presence of this insect. (Hartung)

The *Citrus yellow mosaic virus* was thoroughly characterized by full length genomic sequencing, and the etiology of the disease was established by infecting sweet orange plants with the cloned virus genome using *Agrobacterium*- mediated infection. (Hartung)

The population structure of *Xylella fastidiosa* in Brazil and the United States was characterized with genomic data. (Hartung)

Xylella fastidiosa was transformed with a plasmid shuttle vector for the first time. (Hartung)

Conjugational mating methods were used to create marked mutations in *Xylella fastidiosa*. The mutations are marked with green fluorescent protein, enabling monitoring of the bacterium in planta by confocal microscopy. (Hartung)

With collaborators from Brazil, demonstrated that both the citrus and coffee strains of *X. fastidiosa* can infect and cause symptoms of Pierce's disease in grapevine. This work demonstrates that the infective range of strains of *X. fastidiosa* is effectively unlimited in woody plants, and that symptoms are the result of plant responses to the presence of the pathogen, rather than a result of expression of genes specific to the pathogen. (Hartung)

With collaborators in Brazil demonstrated that the citrus strain of *X. fastidiosa* can extensively colonize sweet orange seed, and be transmitted form the seed to seedlings. (Hartung)

Developed quantitative and real-time PCR based assay for *X. fastidiosa* that will be useful in quantitative analysis of infection of diverse hosts. (Hartung)

Plant Germplasm Quarantine Office

Sweet potato virus disease was shown to be a disease complex that could be induced by a synergistic interaction of sweet potato chlorotic stunt virus with any of several other sweet potato potyviruses, including sweet potato feathery mottle virus, Ipomoea vein mosaic virus, sweet potato virus G, and sweet potato caulimovirus. (Hurtt)

A new indexing protocol for sweet potato was approved that reduced the quarantine period for this crop from about 24 months to 9 months. (Hurtt, Salih)

Twenty-five infected sugarcane accessions were established in vitro and different culture media were evaluated for maintaining different cultivars and species. (Hurtt and Salih)

Thirteen isolates of sweet potato geminiviruses obtained from different regions of world were cloned and sequenced for genetic variation analysis of these viruses. (Li)

A PCR-based method using degenerate primers was developed for the rapid detection of geminiviruses in sweet potato germplasm using greenhouse grown plant tissue or in vitro tissues. Use of the degenerate primers enables detection of broad range of geminiviruses in sweet potato germplasm by the PCR assay. (Li and Hurtt)

A rapid, sensitive, and reliable RT-PCR assay using consensus primers was developed for detection of foveaviruses (Cherry green ring mottle virus and Cherry necrotic rusty mottle virus) in *Prunus* spp. germplasm. (Li and Mock)

A PCR technique to detect gooseberry vein-banding virus was developed for use in the Ribes quarantine program that is more rapid and sensitive than the currently used bio-indicator. (Li and Mock)

Methods were developed to allow for storage of Lilac (*Syringa*) and Kiwi (*Actinidia*) in tissue culture. (Salih)

A new indexing protocol approved for rice, that allows for grow-out and observations of imported rice accessions (except noxious weed species) in a field setting (in collaboration with NC State Universit), should allow for more rice accessions to be processed annually. (Salih)

Developed in vitro and in vivo therapy protocols for infected pome and Prunus accessions (Salih, Kinard, Mock)

Technology Transfer

Fruit Lab (general)

Fruit Lab scientists organized a scientific exhibit annually for BARC Public Field Day, which was viewed by thousands of visitors to the Beltsville Agricultural Research Center.

Fruit Laboratory scientists gave talks on research accomplishments to: 1) a delegation from the United States Blueberry Council, and 2) a large group of blueberry growers from New Jersey. This information should help educate the fruit growers on the significance of the ARS small fruit research at Beltsville, MD and at Chatsworth, NJ.

Fruit Lab scientists hosted a visit from the Board of Directors of the North American Strawberry Growers' Association.

Fruit Laboratory Scientists visited and discussed research programs with representatives from the California Strawberry Commission.

Talks on research in the Fruit Laboratory presented to: 1) the Israeli Minister of Agriculture, 2) scientists from Romania, 3) a writer from American Fruit Grower, 4) scientists from Plant Breeding Institute in Estonia, and 5) scientist from Ben-Gurion University of the Negev, Israel.

Worked with a film crew from Iowa Public TV to produce a film on research in the Fruit Laboratory

Small fruit breeding

A Memorandum of Understanding was established with the University of Minnesota on developing red stele resistant strawberry cultivars adapted to the upper Midwest was maintained.

A Specific Cooperative Agreement was finalized with Nourse Farms, Inc., on freeing small fruit selections from viruses and propagating selections for commercial release.

Advanced strawberry and blueberry selections were distributed to growers for evaluation as potential cultivars.

Material Transfer Agreements were established for more than 300 blueberry selections with 10 researchers and nurserymen in the U.S.

Approximately 2,000 blueberry seedlings were distributed each year to co-operating programs for selection under local conditions.

For the last 35 years, the Fruit Laboratory staff at Beltsville, MD hosted a Strawberry Field Day providing an opportunity for strawberry growers and researchers to see new cultivars and breeding selections under field conditions, and become acquainted with the research of the breeding program

Since, 1991, the Fruit Laboratory staff at Chatsworth, N.J. co-hosted a yearly Blueberry Field Day and Open House with Rutgers University providing an opportunity for Blueberry growers, nursery industry, extension workers, university and government researchers to see new cultivars and breeding selections under field conditions, and become acquainted with the research of the breeding program.

Fruit Laboratory scientists gave talks on research conducted in the Fruit Lab at the 9th North American Blueberry Research & Extension Workers Conference. These talks helped to update researchers from Canada and the US on the current blueberry research program in the Fruit Lab.

Fruit Lab scientists have released a new late season strawberry cultivar for use by growers in the Mid-Atlantic and neighboring regions. This is currently the latest cultivar available and extends the growers' strawberry season.

Talks on small fruit breeding and cultivar development were presented at annual meetings of the North American Strawberry Growers Association, New Jersey Fruit & Vegetable Growers Association (small fruit section), North American Bramble Growers Association, New Jersey Blueberry Open House, the NCR-22 project, the University of Maryland's Strawberry Twilight Meeting at Wye, MD and at the Southeast Strawberry Growers Expo, Raleigh, NC.

Small fruit diseases and pests

Fruit Lab scientists have released two parental strawberry clones for use by breeders to incorporate resistance to the bacterial angular leafspot disease into their strawberry breeding programs.

A CD database of disease screening results from blueberry was distributed to blueberry researchers and interested blueberry growers and nurserymen.

Talks on small fruit disease problems and control were presented at annual meetings of the North American Strawberry Growers Association, Annual New Jersey Vegetable Growers Association (small fruit section), American Cranberry Growers Association, New Jersey Blueberry Open House, New York Area Plant Molecular Biology Meeting and the Michigan Horticultural Society.

Trained researchers from the NJ Dept. of Agriculture for the detection of *Vaccinium* phytoplasmas

Biotechnology/molecular biology of small fruit crops

Material Transfer Agreements were established with seven public and private sector institutions in the U.S. and Canada for distribution of primer sequences for 26 strawberry SSRs.
A talk on SSR development for brambles were presented at the 2004 annual meeting of the North American Bramble Growers Association.

Fruit Laboratory staff gave talks on biotechnology research molecular markers for use with small fruits to a delegation of Armenian scientists. This information will help them in their efforts to use modern breeding techniques to evaluate and enhance their fruit crops.

A Specific Cooperative Agreement was maintained with Iowa State University on identifying cold tolerance genes in related *Ericaceae* species using a genomic approach.

Visiting scientist from Israel was trained in AFLP marker technology.

Visiting scientists from India were trained in protein and RNA analyses, DNA sequencing, primer design, EST analyses, and bioinformatics.

Blueberry dehydrin clones and antibodies were provided to scientists at Rutgers University, Iowa State University, and ARS.

ESTs and EST-PCR primer sequences were provided to scientists at the National Clonal Germplasm Repository in Corvallis, OR, prior to their submission to GenBank to assist in developing SSR markers for blueberry and in developing DNA fingerprints of genotypes in their blueberry germplasm collection.

An EST database for blueberry, comprised of ~1300 sequences, was developed and made publicly available by submission to GenBank.

Fruit Lab scientists provided strawberry derived SSR primers and sequences and associated protocols to collaborators and colleagues with Material Transfer Agreements. Institutions involved were The University of Pittsburgh, The University of Minnesota, California Seed and Plant Lab, Driscoll Strawberry Associates, Inc., Foundation Plant Materials Service of the University of California, Michigan State University, and the University of Guelph. The findings from these projects indicates that SSR molecular markers derived from a horticultural crop, cultivated strawberry, are useful to researchers studying wild strawberry diversity, strawberry evolution, strawberry population genetics, and strawberry pollen movement in nature.

Fruit Laboratory scientists at Beltsville, MD provided information to a journalist with the USDA Information Staff for an article in the Agricultural Research Magazine on a new procedure to produce 'Bluecrop' blueberry plants from cell cultures. This article will help to update the public on current blueberry biotechnology research being conducted in Beltsville.

Presented talks on Fruit Crop Biotechnology to: 1) an International Trade Delegation participating in the U.S. State Department U.S. Agriculture and World Economy Project, 2) members of the Philippine Senate, 3) scientists from Huazhong Agricultural University, P.R. China, and 4) Agricultural Engineer from the Chilean Agricultural and Livestock Service.

Provided technical information to Van Zanten Research, The Netherlands, on using tissue culture techniques to obtain disease resistance.

Provided technical information to Sakuma Bros. Farms, Burlington, WA, by providing them with a protocol on blueberry regeneration from cell culture.

Article written for ARS Research Magazine on Regeneration of blueberry cultivar Bluecrop from cell culture.

Provided protocols on tissue culture propagation of blueberry to: 1) blueberry grower from New Jersey, 2) Dry Creek Laboratory, Modesto, CA, and 3) Agristarts, Florida.

In the past five years, visited with and /or provided scientific guidance on fruit crop biotechnology research to approximately 500 scientists from 35 countries.

Small fruit crop sustainable production systems

A Beltsville Strawberry Field Day was organized annually for the Mid-Atlantic region strawberry growers, nursery industry, extension workers, university and government workers.

Talks on small fruit production practices were presented at annual meetings of the North American Strawberry Growers Association, the Southeast Strawberry Growers Expo, Mid-Atlantic Fruit and Vegetable Conference, Ohio Fruit and Vegetable Growers Congress, Wisconsin Fresh Fruit and Vegetable Conference, the University of Maryland's Strawberry Twilight Meeting and at the NCR-22 Small Fruit Research Committee meeting.

A Cooperative Research and Development Agreement was established with Valent Biosciences Corp. to test plant growth regulator formulations for vegetative control of strawberry.

Citrus diseases

Three invited trips to Sao Paulo State Brazil to serve on grant review panels (2/2000;FAPESP) and plan collaborative research (Fundecitrus and University of Sao Paulo)

Invited lectures/talks on Molecular Analysis of Plant Pathogenic Bacteria, Citrus and Strawberry Quarantine Diseases and Control, and *Xylella*, *Xanthomonas* and *Liberobactor*-Exploiting the Genome were presented at the 23rd Congress Paulista de Fitopatologia, (Brazil) Huazhong Agricultural University(China) and the University Industry Consortium (Crystal City, Virginia), respectively.

Two presentations at the International Citrus Canker Workshop sponsored by USDA APHIS and the Florida Department of Plant Industry, Fort Pierce, FL.

Two presentations at the Workshop Exotic Vectored Pathogens of Citrus. This workshop was sponsored by the University of Florida, Citrus Research and Education Center, Lake Alfred, FL

At the request of Edwin Imai, Commodity Risk Assessment, USDA APHIS PPQ, reviewed 'A new Detection Method for *Xanthomonas axonopodis pv citri* on Citrus Fruits' and 'Korean Mandarin Work Plan'. These documents were prepared by Korean researchers interested in gaining access to the US market for Mandarin type oranges. April 13, 2001.

Provided the California Department of Food and Agriculture with reports describing real time quantitative PCR-based methods for detection of *Xylella fastidiosa* and Liberobacter spp.

Two presentations at the International Citrus Canker Workshop sponsored by USDA APHIS and the Florida Department of Plant Industry, Fort Pierce, FL.

Plant Germplasm Quarantine Office

Unconditionally, conditionally or provisionally released 3920 accessions since 1999. By crop, these releases included: 1,264 rice accessions, 963 Prunus, 313 clonal potatoes, 270 sugarcane introductions from foreign sources and 266 from domestic donors, 163 lots of true potato seeds, 110 sweet potatoes, 161 grasses, 194 apples, 150 pears, 25 quince, 25 Ribes, 4 Rubus, 5 corn, 4 maples, and 3 kiwi.

Organized and hosted annual meetings of the PGQO Liaison Committee to facilitate exchange of information between clients and PGQO staff.

Supplied pathogen cultures to Agdia, Inc. to be used as positive controls in pathogen test kits.

Genomic DNA from two cassava accessions held in quarantine were transferred to the Clemson University Genomics Institute where it is being used to generate a genomic map for that species. The germplasm itself was pathogen infected and could not be released from quarantine.

Nucleic acid extraction method developed for PCR detection of sweet potato geminivirus was transferred to ARS scientists in Griffin, GA.

Provided four isolates of sweet potato infecting geminiviruses to University of Arizona for comparative research.

Leaf samples and immature embryos of a grass accession *(Tripsacum* sp.) were provided to Utah State University for research purposes. The entire plants could not be released because they were infected with a pathogen of quarantine significance.

As an expert consultant on the Potato Technical Advisory Group for the North American Plant Protection Organization (NAPPO), participated in writing guidelines for the safe exchange of potato germplasm among the three NAPPO member countries and the production of minitubers in Mexico for export.

Served as a consultant and transferred technology to a pathologist in Alaska who is responsible for establishing a quarantine and indexing program to import foreign potato germplasm into that state.

Served as an expert consultant to US scientists investigating the etiology of sweet potato diseases in Jamaica. Ran serological and biological assays for the group and provided data on the viruses detected in the germplasm and demonstrated the techniques used.

Talks/reports were presented by PGQO scientists on quarantine topics at numerous regional, national, and international meetings: BARC Poster Day, WCC 20 (Virus and virus-like diseases of fruit trees, small fruits, and grapevines), NE-1006 (eradication, containment, and/or management of plum pox disease), nine different Crop Germplasm Committees, Plant Germplasm Operations Committee, GRIN Advisory Committee, North America Fruit Explorers (NAFEX), U.S. Blueberry Council, American Phytopathology Society Annual Meeting, 8th International Congress of Plant Pathology, 18th International Symposium on Virus and Virus-like Diseases of Temperate Fruit Crops, 1st International Symposium on Sweet Potato.

Met with scientists of INIA in Uruguay to plan program for testing of plant germplasm under quarantine.

Participated in the Technical Committee review of the USDA-ARS National Clonal Germplasm Repository. Corvallis Oregon.

CRIS PROJECTS & FUTURE PLANS

FINANCIAL

ADMINISTRATIVE ISSUES

SCIENTISTS' CONTRIBUTIONS

In-House CRIS Summary

CWU Number	TITLE	SY(s)	Time	Net to Location	National Programs
1275-21000-157-00D *Start Date: 06/13/02* *Term Date: 08/31/06* 0405671	*Enhancement of Blueberry and Strawberry Through Analysis and Modification of the Plant Genome*	L. Rowland K. Lewers M. Ehlenfeldt J. Polashock F. Hammerschlag	1.00 SY 0.40 SY 0.20 SY 0.20 SY 0.20 SY	$904,440	301 30% 302 70%
1275-21000-160-00D *Start Date: 09/07/02* *Term Date: 08/31/06* 0405997	*The Role(s) of Heat Shock Proteins in the Responses of Small Fruit Crops to Elevated Temperature*	J. Slovin F. Hammerschlag	1.00 SY 0.05 SY	$297,013	302 100%
1275-21000-163-00D *Start Date: 05/01/03* *Term Date: 04/30/08* 0407108	*Federal Quarantine for International and Domestic Movement of Saccharum (Sugarcane)Genetic Resources*	S. Hurtt R. Li F. Hammerschlag	0.50 SY 0.50 SY 0.05 SY	$310,623	301 100%
1275-21000-175-00D *Start Date: 11/16/03* *Term Date: 11/15/08* 0407846	*Small Fruit Crops in Sustainable Production Systems*	B. Black Vacant (Maas) S. Wang F. Hammerschlag	1.00 SY 0.40 SY 0.20 SY 0.15 SY	$495,732	302 40% 305 60%
1275-21220-186-00D *Start Date: 04/17/03* *Term Date: 04/16/08* 0407048	*Federal Quarantine for the Importation of Plant Genetic Resources*	G. Kinard R.Mock S. Hurtt R. Li F. Hammerschlag	1.00 SY 1.00 SY 0.50 SY 0.50 SY 0.25 SY	$1,432,676	301 100%
1275-21220-213-00D *Start Date: TBD* *Term Date: TBD* 0405738	*Enhancement of Small Fruit Germplasm Through Genomic Characterization & Genetic Improvement with Emphasis on Disease*	M. Ehlenfeldt J. Polashock S. Wang K. Lewers Vacant (Maas) F. Hammerschlag	0.80 SY 0.80 SY 0.80 SY 0.60 SY 0.60 SY 0.20 SY	$1,075,889	301 100%
1275-22000-204-00D *Start Date: 03/27/03* *Term Date: 03/26/08* 0407008	*Exotic Pathogens of Citrus*	J. Hartung F. Hammerschlag	1.00 SY 0.10 SY	$594,311	303 70% 301 30%
		Net to Location TOTAL:		**$5,110,684**	

National Programs

301 Plant, Microbial & Insect Germplasm Conservation & Development

302 Plant Biological & Molecular Procedures

303 Plant Diseases

305 Crop Production

CRIS PROJECT LISTING

1275-21000-157-00D
Enhancement of Blueberry and Strawberry Through Analysis and Modification of the Plant Genome

Investigators:

Lisa J. Rowland (Lead)	100%
Kimberly S. Lewers	40%
Freddi A. Hammerschlag	20%
Mark K. Ehlenfeldt	20%
James J. Polashock	20%

Scientific Staff Years: 2.00
Funding: $904,440
National Program: 302 Plant Biological and Molecular Processes (70%)
301 Plant, Microbial and Insect Genetic Resources, Genomics, and Genetic Improvement (30%)
OSQR Status: Approved

Start Date: 06/13/2002 Termination Date: 08/31/2006

Objectives (Final Project Plan):
The overall objectives are to identify genes/molecular markers of horticultural significance in blueberry and strawberry, to make them available for marker-assisted breeding and transformation of small fruit cultivars, and to develop optimum tissue culture and gene transfer technologies for introducing disease resistance, cold tolerance and chilling requirement determining genes into small fruits.

1. Continue isolating and characterizing the dehydrin gene family of blueberry, for which a correlation between its expression and cold hardiness of floral buds exists, as well as search for new chilling/cold-responsive genes using a genomic approach.

2. Map chilling/cold-responsive genes and other "candidate" genes and determine if any map to QTLs that control chilling requirement or cold hardiness.

3. Develop optimum conditions for gene delivery, selection, and regeneration of transgenics of several important strawberry and blueberry cultivars developed for the eastern United States.

4. Utilize transformation technologies to introduce cold tolerance genes into elite blueberry cultivars and identify disease resistance genes and develop in vitro disease resistance screening methods for elite strawberry cultivars. If time allows, introduce disease resistance genes into strawberry.

1275-21000-160-00D
The Role of Heat Shock Proteins in the Responses of Small Fruit Crops to Elevated Temperature

Investigators:
Janet P. Slovin (Lead) 100%
Freddi A. Hammerschlag 5%

Scientific Staff Years: 1.05
Funding: $297,013
National Program: 302 Plant Biological and Molecular Processes
OSQR Status: Approved

Start Date: 09/07/2002 Termination Date: 08/31/2006

Objectives (Final Project Plan):
The long-term objectives of this project are to determine if specific proteins expressed by small fruit crops in response to heat stress function as part of the thermotolerance system, and if so, to determine the mechanism(s) of their action and the potential for utilizing these proteins to improve crop stress responses.

1. Develop better tools for investigating the role of heat shock proteins (Hsps) or other gene products in strawberry thermotolerance. These will include an inbred diploid testing system, as well as assays for thermotolerance that will have physiological and/or agricultural relevance.

2. Determine mechanisms by which Hsps or other gene products affect thermotolerance by using standard molecular and biochemical assays for chaperone function, intracellular localization, and protein-protein interaction.

1275-21000-163-00D
Federal Quarantine for International and domestic Movement of *Saccharum* Genetic Resources

Investigators:

Suzanne S. Hurtt (Lead)	50%
Ruhui Li	50%
Freddi A. Hammerschlag	5%

Scientific Staff Years: 1.05
Funding: $310,623
National Program: 301 Plant, Microbial and Insect Genetic Resources, Genomics, and Genetic Improvement
OSQR Status: Approved

Start Date: 05/01/2003 Termination Date: 04/30/2008

Objectives (Final Project Plan):
Federal and state regulations prohibit the importation of *Saccharum* species unless the plant materials (seed and vegetative plant parts) are shown to be free of undesirable pests. To facilitate the exchange of *Saccharum*, plants and seed lots must be held in quarantine and tested for pathogens. A significant quantity of the germplasm will be diseased and will have to undergo therapeutic treatments before it can be moved into and within the US. Quarantine and therapy will become more efficient through the development and use of new technologies.

1. Quarantine and test *Saccharum* genetic resources to meet federal and state regulations for importation and exchange.

2. Develop and use new or improved methods for eliminating sugarcane pathogens.

3. Develop and apply new or improved methods to diagnose and detect sugarcane pathogens.

1275-21000-175-00D
Small Fruit Crops in Sustainable Production Systems

Investigators:

Brent L. Black (Lead)	100%
Vacant (Maas)	40%
Shiow Y. Wang	20%
Freddi A. Hammerschlag	15%

Scientific Staff Years: 1.75
Funding: $495,732
National Program: 305 Crop Protection (60%)
302 Plant Biological and Molecular Processes (40%)
OSQR Status: Approved

Start Date: 10/09/2003 Termination Date: 10/08/2008

Objectives (Final Project Plan):
The overall objective of this research is to investigate physiological, environmental, nutritional and pathological factors influencing growth and productivity of small fruit crops, in order to identify approaches for improving sustainability of production systems.

1. Develop and evaluate small fruit production practices and systems for sustainability.

2. Develop non-chemical approaches for controlling soil-borne pathogens of small fruit crops, and understand the effects of production practices on soil microbial populations. Emphasis will be on the strawberry Black Root Rot disease complex (BRR).

3. Provide opportunities for diversification by developing alternative production practices and identifying alternative fruit crops.

1275-21220-186-00D
Federal Quarantine for the Importation of Plant Genetic Resources

Investigators:

Gary R. Kinard (Lead)	100%
Raymond G. Mock	100%
Suzanne S. Hurtt	50%
Ruhui Li	50%
Freddi A. Hammerschlag	25%

Scientific Staff Years: 3.25
Funding: $1,432,676
National Program: 301 Plant, Microbial and Insect Genetic Resources, Genomics, and Genetic Improvement
OSQR Status: Approved

Start Date: 04/17/2003 Termination Date: 04/16/2008

Objectives (Final Project Plan):

1. Efficiently process prohibited genera of foreign germplasm through federal quarantine and distribute released germplasm to customers. Data on accessions are maintained in a local database, and relevant data are also transferred to GRIN.

2. Prevent introduction of quarantine pathogens in imported prohibited germplasm using a range of diagnostic techniques to intercept them.

3. Develop improved methods of detecting quarantine pathogens and investigate the etiology of poorly described diseases and pathogens of quarantine significance.

4. Eliminate quarantine pathogens from valuable plant germplasm.

1275-21220-213-00D (*previously 1275-21220-181-00D*)
Enhancement of Small Fruit Germplasm Through Genomic Characterization and Genetic Improvement with Emphasis on Disease

Investigators:

Mark K. Ehlenfeldt (Lead)	80%
Shiow Y. Wang	80%
James J. Polashock	80%
Kimberly S. Lewers	60%
Vacant (Maas)	60%
Freddi A. Hammerschlag	20%

Scientific Staff Years: 3.80
Funding: $1,075,889
National Program: 301 Plant, Microbial and Insect Genetic Resources, Genomics, and Genetic Improvement
OSQR Status: Approved, with minor revisions - CRIS is expected to be certified within a few weeks

Start Date: to be determined Termination Date: to be determined

Objectives (Project Plan):
This project focuses on two main research areas: 1) breeding to develop superior small-fruit germplasm and cultivars, and 2) the identification and characterization of disease resistance in small-fruits. Specifically, the breeding research is directed at originating improved small-fruit germplasm and cultivars that combine resistance to the prevalent diseases of several growing regions along with the highest productivity and fruit quality possible. The pathology studies are targeted at developing improved disease screening methods, identifying and evaluating disease resistant germplasm, and developing improved methods of incorporating resistances into superior germplasm. The two objectives are closely related, and are often carried out in concert. Both aspects are necessary to provide new varieties that will benefit small-fruit growers and consumers.

1. Develop small-fruit cultivars that combine disease resistance, broad environmental adaptation, high yield, and excellent fruit and plant quality characteristics.

2. Identify and utilize disease-resistant small fruit genotypes, assays, and resistance mechanisms for the development of resistant cultivars.

1275-22000-204-00D
Exotic Pathogens of Citrus

Investigators:

John S. Hartung (Lead)	100%
Freddi A. Hammerschlag	10%

Scientific Staff Years: 1.10
Funding: $594,311
National Program: 303 Plant Diseases (70%)
301 Plant, Microbial and Insect Genetic Resources, Genomics, and Genetic Improvement (30%)
OSQR Status: Approved

Start Date: 03/27/2003 Termination Date: 03/26/2008

Objectives (Final Project Plan):

1. Establish the etiology of novel diseases of citrus and characterize the pathogens responsible for them.

2. Develop novel rapid, sensitive and quantitative diagnostic tests for the presence of exotic citrus pathogens in plant tissues.

3. Identify the virulence mechanisms used by exotic pathogens with a combination of genetic and functional genomic techniques.

4. Maintain and facilitate cooperative research on the Exotic Pathogens of Citrus Collection (EPCC).

Outside Funding and Extramural CRIS Projects

1275-21000-157-02S (Specific Cooperative Agreement with Iowa State University)
A Genomic Approach to the Identification of Cold Tolerance Genes in Related *Ericaceae* Species
Investigator: Lisa J. Rowland
Start: 03/01/2003 Termination: 02/28/2004

1275-21000-175-01R (Reimbursable IPM grant with Michigan State University)
Cultural and Biological Alternatives to Methyl Bormide Fumigation in Strawberries
Investigator: Brent L. Black Funding: $14,549
Start: 09/01/2002 Termination: 10/01/2004

CRADA with Valent BioScience Corp.
Supression Strawberry Runners with VBC-30025
Investigator: Brent L. Black Funding: $10,000
Start: 06/01/2003 Termination: 05/31/2005

Memorandum of Understanding with University of Minnesota
Develop Strawberry Cultivars Adapted to the Upper Midwestern United States
Investigator: Kimberly S. Lewers
Start: 08/01/1998 Termination: 07/31/2004

1275-22000-204-02S (Specific Cooperative Agreement with University of Florida)
Historical Diversity and Rapid Detection of *Xanthamonas Axonopodis* pv. *Citri*
Investigator: John S. Hartung
Start: 10/01/2003 Termination: 12/31/2005

Grants Applied For

1275-21000-157-00D (Reimbursable with North American Bramble Growers Association)
SSR Markers for Brambles
Investigator: Kimberly S. Lewers — Funding: $4,367
Start: 03/01/2004 — Termination: 02/28/2005

1275-21000-157-00D (Reimbursable with NRI-CGP/CSREES)
QTL Mapping and Marker-Assisted Selection of Strawberry Genotypes Resistant to Bacterial Angular Leafspot Disease
Investigator: Kimberly S. Lewers — Funding: $301,830
Start: 07/01/2004 — Termination: 06/30/2006

1275-21000-157-00D (Reimbursable with NRI-CGP/CSREES
Analysis of Gene Expression Associated with Cold Acclimation in Blueberry Floral Buds Using Expressed Sequence TAGS and CDNA Microarrys
Investigator: Lisa J. Rowland — Funding: $316,396
Start: 08/01/2004 — Termination: 07/31/2006

CRIS PROJECT ACCOMPLISHMENTS

ENHANCEMENT OF BLUEBERRY AND STRAWBERRY THROUGH ANALYSIS AND MODIFICATION OF THE PLANT GENOME (1275-21000-157-00D)

Accomplishment: ***Developed the first publicly available expressed sequence tag (EST) database for blueberry.*** The database is currently comprised of approximately 1300 sequences, 600 5' end sequences and 100 3' end sequences from a cDNA library made from cold acclimated floral buds and 600 5' end sequences from a cDNA library made from non-acclimated floral buds. A comparison of the ESTs from the two libraries, followed by northern analysis, has resulted in the identification of seven new cold acclimation-responsive genes. **Role:** Dr. Rowland conceived the experiments. She designed experiments along with postdoctoral visiting scientist, Dr. Anik Dhanaraj. She directed Dr. Dhanaraj in the performance of experiments. Dr. Dhanaraj wrote a draft of the manuscript, which Drs. Rowland and Slovin revised. **Impact:** This work provides the basis for future microarray work to examine expression of these genes under cold acclimating and deacclimating conditions. The availability of these sequences has resulted in the development of EST-PCR markers by Dr. Rowland and co-workers for mapping, DNA fingerprinting, and genetic relatedness studies in blueberry. Several of the EST-PCR markers have been added to Dr. Rowland's current genetic linkage maps of blueberry. Drs. Rowland, Dhanaraj, Polashock, and Arora have shown that the blueberry-derived EST-PCR markers are useful for genetic studies in related *Ericaceae*, cranberry and rhododendron. SSR-containing ESTs have been used by scientists at the National Clonal Germplasm Repository (Corvallis, Oregon) to develop SSR markers for fingerprinting and determining genetic relatedness of genotypes within the national blueberry germplasm collection. An aliquot of the blueberry cDNA library made from non-acclimated floral buds has been transferred to members of the "Floral Genome Project", Dept. of Biology, Pennsylvania State Universty, under an MTA, to help identify genes involved in flower development.

Accomplishment: ***Developed high efficiency shoot regeneration and gene delivery systems for several commercially important highbush blueberry cultivars including the regeneration-recalcitrant cultivar Bluecrop.*** **Role:** Drs. Hammerschlag and Rowland conceived this project. Dr. Hammerschlag and visiting scientists conducted tissue culture and transformation studies. All manuscripts were written by Dr. Hammerschlag and Dr. Douglass contributed to the statistical analyses. **Impact:** The shoot regeneration and gene delivery protocols will be used by Dr. Hammerschlag and other scientists to develop reliable transformation systems for blueberry and will make it possible for scientists to generate useful variation via tissue culture. A reliable transformation system will enable Drs. Rowland and Hammerschlag to study the function of dehydrin genes in cold hardiness, and ultimately to regulate cold hardiness in blueberry. A reliable gene transfer system will also be used by Dr. Hammerschlag and collaborator Dr. Jim Polashock to introduce disease resistance genes into blueberry. Bluecrop is the most widely grown blueberry cultivar. Developing a regeneration protocol for this cultivar opens up the possibility of improving it either through tissue culture and/or gene transfer techniques. Requests for the blueberry shoot regeneration and gene delivery protocols have been received from scientists in 16 countries.

Accomplishment: ***Developed and tested some of the first SSR markers for strawberry.*** Twenty-six SSR primer pairs were developed from sequences of genomic clones of 'Earliglow' strawberry and 24 from ESTs archived in GenBank. Comparisons were made between genomic-derived and GenBank-derived SSRs in PCR reactions with DNA from several strawberry species in addition to raspberry and blackberry. Nearly all of the SSRs can be used with multiple strawberry species, about 30% can be used with blackberry, and about 20% can be used with raspberry. SSRs derived from GenBank ESTs with six or more repeats were as useful as those derived from genomic clones and were much faster to design. **Role:** Dr. Hokanson conceived the experiments to develop SSRs from genomic clones. Drs. Hokanson and Styan conducted the experiments to design SSR primers from genomic clones. Dr. Lewers conceived the experiments to develop SSRs from GenBank sequences and tested both the genomic-derived and GenBank-derived SSRs for efficacy. Dr. Lewers collaborated with Dr. Bassil to identify the most efficient method to identify repeat regions in GenBank sequences and to determine gene regions most likely to provide SSRs of superior utility. Dr. Lewers wrote a draft of the manuscript that was revised by herself and Dr. Bassil. **Impact:** This research provides the basis for future work in genetics and breeding of strawberry, blackberry, and raspberry. SSR markers currently are being used for genetic mapping, cultivar identification, and phylogenetic studies. SSRs have been used to demonstrate that chromosomes of the paternal progenitor species of cultivated strawberry sort as they would in a diploid species, indicating that incorporation of important traits from wild to domesticated strawberry may be easier than previously thought. One SSR marker has been associated with resistance to bacterial angular leafspot disease of strawberry. This research will lead to the use of SSRs in marker assisted selection of progeny with desired traits.

THE ROLE(S) OF HEAT SHOCK PROTEINS IN THE RESPONSES OF SMALL FRUIT CROPS TO ELEVATED TEMPERATURE (1275-21000-160-00D)

Accomplishment: ***Developed an inbred line of strawberry.*** The commercially grown strawberry, *Fragaria* x *ananassa,* is octoploid, making it difficult to interpret the results of crosses and to analyze the results of transformation experiments. Dr. Slovin has developed an inbred line of the diploid strawberry *Fragaria vesca* that can be easily regenerated from tissue culture, and she has obtained molecular evidence that the genome of *Fragaria vesca* contributes to the genome of the commercial strawberry. **Role:** Dr. Slovin realized the need for such a line, chose the initial progenitor, maintained the plants and performed the selfing, evaluated the progeny, and made the selections. **Impact**: A diploid inbred line of *Fragaria vesca* forms the basis for all future experiments to evaluate the role of genes in all aspects of plant growth and development, and to evaluate the role of specific genes in response to abiotic and biotic stress using transformation and mutagenesis. Because of its small genome size and its growth habits, *Fragaria vesca* is an excellent model system for studying woody perennials, and the availability of an inbred line is essential to setting up such a model system.

Accomplishment: ***Construction of a*** **cDNA library of diploid strawberry**. A cDNA library has been constructed using RNA from heat treated seedlings of *Fragaria vesca* growing aseptically on agar. The library has been screened for specific sequences putatively involved in thermal stress responses using heterologous or homologous probes obtained by PCR of Arabidopsis or strawberry DNA. In addition, we have so far obtained 63 EST sequences from this library. Altogether, we have obtained EST or comprehensive sequence data for several Hsps, heat shock factors, transcription factors associated with flowering, and numerous other genes from *Fragaria vesca*. **Role:** Dr. Slovin initiated this project, determined optimum conditions for treating plants prior to extraction of RNA, determined the best procedure for isolating the RNA, and arranged for construction of the library. A post-doc, Dr. Dhanaraj, in Dr. Rowland's lab isolated the RNA. Dr. Slovin has screened the library for several genes, and together with a student helper is continuing to obtain EST sequence data. **Impact:** This work sets up strawberry as a useable molecular system for doing targeted crop improvement. The availability of sequence data from strawberry is useful for development of genetic markers, will enable us to obtain useful promoter sequences, and facilitate studies on the evolution of genes in polyploid species. This work is fundamental to our future work to examine the effects of heat stress on expression of genes involved in flowering and fruit production in dayneutral varieties of strawberry. Day neutral varieties that flower and produce quality fruit throughout the hot summer months, rather than solely in May or June, are needed by growers in the northeastern US.

Accomplishment: ***A low molecular weight heat shock protein shown to be involved in thermotolerance.*** All organisms examined so far produce specific sets of proteins, called heat shock proteins, in response to heat stress. Plants, however, uniquely produce an abundance and variety of the low molecular weight heat shock proteins (lmwHsps). Although a large amount of research has been done to correlate the presence of particular lmwHsps with thermotolerance, only one genetic study has accomplished this. Using molecular techniques, a lmwHsp from carrot (Hsp 17.7) has now been demonstrated by Dr. Slovin and her colleagues to be involved in the

development of thermotolerance. Carrot cell lines and plants transformed with a construct containing antisense Hsp 17.7 driven by the endogenous heat shock promoter were shown to be less able to develop acquired thermotolerance. Antisense constructs using the CaMV 35S promoter resulted in the inability to obtain transformants. The novel use of the endogenous promoter resulted in the ability to obtain transgenic plants expressing the antisense. Tomato plants, transformed to constitutively overexpress the heterologous Hsp 17.7 have been determined to be more thermotolerant than wild-type plants using two different types of assay. **Role:** In collaboration with Dr. Lynn Zimmerman at the University of Maryland, Baltimore County, Dr. Slovin directed the research of a postdoctoral associate supported by their USDA/NRI and NSF competitive grants, which proposed and supported this line of research. Dr. Slovin was fully responsible for all aspects of the work on tomato and is currently developing related systems in strawberry. **Impact:** This was the first direct evidence that lmwHsps are involved in thermotolerance in plants, and that they can be used to develop more stress resistant varieties of crop plants. The tomato plants documented in the resulting patent are the first plants modified with a heterologous gene to show improved thermotolerance.

FEDERAL QUARANTINE FOR INTERNATIONAL AND DOMESTIC MOVEMENT OF SACCHARUM (SUGARCANE) GENETIC RESOURCES (1275-21000-163-00D)

Accomplishment: ***Released 270 Saccharum spp. that were imported from foreign countries or non-mainland states and territories since 1999.*** During this same period, tested and released 266 clones of *Saccharum* spp. as part of the quarantine for interstate movement of sugar cane germplasm. No germplasm has been introduced into the program since 2001 since there has been no greenhouse space available to PGQO for growing the sugar cane. **Role:** Ms. Hurtt is responsible for the acquisition, testing and release of sugar cane. **Impact:** The testing, release, and distribution of this material provides germplasm that is essential for many private, state and federal breeding programs in the US, particular those in Florida, Texas, Louisiana, and Hawaii. The germplasm is also provided to the World Repository for Sugarcane in Florida and to scientists and curators in foreign countries, thereby preserving the genetic diversity for future generations. The program prevents the introduction of exotic or economically-important pathogens that would threaten many US crops, such as corn and sorghum. Eradication or control of these agents would be costly for US agriculture, should the pathogens be introduced during germplasm movement.

Accomplishment: ***A tissue culture program for sugar cane was implemented in 2002.*** The new program was implemented primarily to enable PGQO to utilize *in vitro* techniques to eliminate pathogens, particularly viral pathogens, from infected germplasm. Tissue culture methods were compared and a model system was selected for use in PGQO. Sugar cane clones infected with different pathogens were established in tissue culture. **Role:** Dr. Salih was responsible for testing the various methods for establishing and growing sugar cane and related species in tissue culture. Ms. Hurtt provided healthy and infected cane setts. **Impact:** Much of the highly-desirable germplasm is unavailable to US scientists because it is available only as infected germplasm in foreign countries. The diseases are usually caused by viral pathogens that are not eliminated by the hot water treatments used to eradicate bacterial, fungal, insect, and arthropod pests in sugar cane germplasm. By establishing a tissue culture program for sugar cane, the laboratory can now move on to the task of developing therapeutic methods for the various pathogens and making this germplasm available to scientists and curators worldwide.

SMALL FRUIT CROPS IN SUSTAINABLE PRODUCTION SYSTEMS (1275-21000-175-00D)

Accomplishment: ***A new production system for cool-climate strawberry production was developed and evaluated.*** This Advanced Matted Row system incorporates aspects of both conventional matted row management and annual hill plasticulture production. The system compares favorably to existing production practices used in the mid-Atlantic and mid-western U.S., with lower establishment costs than plasticulture, and reduced soil erosion, and better weed control than conventional matted row practices. **Role:** Under the direction of Drs. Gene Galletta and Stan Hokanson, Support Scientist John Enns developed the basic concepts of this production system. Dr. Black has conducted field experiments to compare this system to existing production practices, and has investigates individual components of this system including planting date, plant spacing, and cover crops compatibility. **Impact:** With the impending loss of methyl bromide, strawberry growers are looking for efficient production practices for disease and weed control. The impact of this work is evident by invitations to present research findings at one international research conference, four multi-state grower meetings in the eastern and mid-western U.S., and by articles in several trade publications. Requests for information have been received from both the U.S. and Canada, and several growers in the mid-Atlantic region are experimenting with this approach. As conventional matted row growers look for ways to improve efficiency, this system may become important in colder regions where potential for annual hill plasticulture remains marginal.

Accomplishment: ***Demonstrated the effects of production practices on strawberry fruit quality.*** Strawberries are produced in different cultural systems that may affect fruit quality. Fourteen strawberry cultivars and selections were grown in two cultural systems, the conventional matted row and annual hill plasticulture, at Beltsville Maryland. Fruit samples were analyzed for quality and antioxidant capacity by ARS scientists. Results indicated that fruit produced in the annual hill system had higher fruit soluble solids content, total sugar, fructose, glucose, ascorbic acid, titratable acid, citric acid contents, flavonoid contents and antioxidant capacity. **Role:** Dr. Gene Galletta conceived the project. Dr. Wang analyzed fruit samples and published results. **Impact:** These results add to a growing body of literature that indicates the importance of production practices and environmental factors that influence fruit quality, including phytonutrient content. As interest increases in the human health benefits of fruit consumption, this research will be important in evaluating how changes in cultural practices may result in altered fruit quality.

Accomplishment: ***A method was developed for growing highbush blueberry on upland sites using municipal by-products as constituents in a soil-free substrate.*** Highbush blueberry plants are native to low-pH sandy soils with high organic matter content, and are not very tolerant of upland soils. Combinations of municipal by-products (coal ash and composts) were tested as soil substitutes. A combination of coal ash and biosolid compost resulted in better plant growth and increased early yields compared to both upland (Manor clay loam) and blueberry soils (Berryland sand). **Role:** The project was initiated by Drs. Zimmerman and Korcak formerly of the Fruit Lab. Dr. Black completed this initial study and is conducting a follow-up study to further refine this

production method. **Impact:** Much of the small fruit produced in the eastern and mid-western U.S. is sold directly to the consumer through pick-your-own and farm stand sales. Direct-market oriented fruit growers are interested in growing highbush blueberry, but often do not have suitable soils. Results from this research have been reported at grower field days and at national and international scientific meetings. A number of growers have requested additional information and at least one grower in the mid-Atlantic region has obtained coal ash to test as a soil amendment in a new highbush blueberry planting.

ENHANCEMENT OF SMALL FRUIT GERMPLASM THROUGH GENOMIC CHARACTERIZATION AND GENETIC IMPROVEMENT WITH EMPHASIS ON DISEASE (1275-21220-181-00D) (*CRIS Project just changed to 1275-21220-213-00D*)

Accomplishment: ***Released a June-bearing strawberry cultivar, 'Ovation' with an exceptionally late fruiting season.*** 'Ovation' fruit are large and very attractive with good flavor and high nutritional quality. Yields under plasticulture production are among the highest in replicated evaluations in Maryland. Yields in advanced matted row culture are average. High production levels are realized in New Jersey, Pennsylvania, and Ohio as well. **Role:** Dr. Galletta (retired) crossed 'Lateglow' × 'Etna' in 1989. Dr. Galletta, Dr. Maas (retired), and Mr. Enns (Support Scientist) screened the seedlings from that cross for resistance to red stele. Later, Dr. Galletta, Dr. Hokanson (former Research Geneticist), Mr. Enns, Dr. Lewers and collaborators at several other locations evaluated 'Ovation'. Dr. Wang evaluated the fruit for nutritional quality. Dr. Smith (USDA-ARS, Poplarville, MS) evaluated the plants for resistance to anthracnose crown rot. Dr. Lewers characterized 'Ovation' with SSR molecular markers. **Impact:** 'Ovation' is valuable for its fruit quality and high potential yields, and it also is very valuable to growers as a season extender. In New Jersey, where plasticulture is being used, 'Ovation's high yield and late season combine to earn it a recommendation from the New Jersey Extension Service as the late-season cultivar for the state.

Accomplishment: ***Sources of disease resistance in blueberry identified.*** More than 100 blueberry cultivars and wild species material were screened for resistance to mummy berry blight, mummy berry fruit-rot, and anthracnose fruit-rot under high inoculum conditions. Sources of resistance were identified, and clones with multiple resistances were selected as parental material, and incorporated into the breeding program. The information derived from these screenings has been assembled into a database distributed to growers, extension workers, plant pathologists, and breeders. **Role:** Dr. Ehlenfeldt and Dr. Stretch (retired) conceived the project, and assembled and screened the collection of cultivars adapted to a wide range of U.S. climatic regions. Dr. Polashock performed mummy berry evaluations on *Vaccinium* species. **Impact:** This information is being used to breed more disease resistant cultivars. The information is also being used by growers and extension workers to make disease management decisions under field conditions, and to aid in the selection of cultivars for field planting. This information has proven especially useful to the nascent organic blueberry production industry.

Accomplishment: ***Antioxidant capacity in berry crops is affected by genotype, maturity, growth and storage temperatures, and cultural conditions.*** Assayed fruit and leaves of various small-fruits and demonstrated that leaves have higher antioxidant activity than fruits, and that antioxidant content of leaves is not correlated with those of fruit. Chokeberries were shown to have the highest levels of antioxidants among the fruit tested. Blackberries and strawberries had their highest antioxidant values during the green stage, whereas raspberries generally had the highest activity at the ripe stage. High temperature growing conditions significantly enhanced antioxidant activity. Antioxidant capacity, anthocyanins and total phenolic content increased during storage at temperatures between 0 and 15° C in cranberries. Methyl jasmonate treatment significantly enhanced antioxidant capacities in raspberry. Increased CO_2 resulted in increases in

antioxidant compounds in strawberries. A positive relationship existed between antioxidant values and anthocyanins or phenolic content. **Role:** Dr. Wang conceived the research, refined antioxidant analysis techniques for berry crops, and performed analyses for most berry crops. Drs. Ehlenfeldt and Prior carried out the studies on blueberry. **Impact:** These findings help breeders and growers select the best genotypes and conditions for maximizing antioxidant capacity in fruits for consumers to enhance their health. Papers by Dr. Wang, and by Drs. Ehlenfeldt and Prior were selected as "Hot Papers" by the Journal of Agricultural and Food Chemistry.

FEDERAL QUARANTINE FOR THE IMPORTATION OF PLANT GENETIC RESOURCES (1275-21220-186-00D)

Accomplishment: ***PGQO programs have unconditionally, conditionally or provisionally released 3384 accessions since 1999.*** By crop, these releases included: 1,264 rice accessions, 963 Prunus, 313 clonal potatoes, 163 lots of true potato seeds, 110 sweet potatoes, 161 grasses, 194 apples, 150 pears, 25 quince, 25 Ribes, 4 Rubus, 5 corn, 4 maples, and 3 kiwi. Pathogens of quarantine significance have been intercepted and excluded from entry into the US on economically important plant germplasm and 320 accessions that were infected have been treated using therapeutic methods designed to eliminate the pathogens. **Role:** The responsibilities for establishing and testing prohibited foreign germplasm are divided among Ms. Hurtt (potatoes and sweet potatoes), Dr. Kinard (pome fruits), Mr. Mock (stone and small fruits, grasses, and ornamental/miscellaneous genera), and Dr. Salih (rice, tissue culture, and therapy). Dr. Li coordinates the molecular tests for all the programs and helps to develop or adapt new detection methods. **Impact:** This program allows for the importation of pathogen tested plant germplasm of many economically important plants into the US. Germplasm released from quarantine can be evaluated for its suitability for production in the US and can be used in breeding programs. Many accessions are deposited with the repositories of the National Plant Germplasm System to preserve genetic diversity for the benefit of future generations. An effective quarantine program encourages compliance with federal regulations regarding movement of germplasm and diminishes the temptations to smuggle prohibited plant material into the US. This program intercepts new or emerging pathogens or strains/isolates of a pathogen that could threaten US agricultural security.

Accomplishment: ***Obtained approval from APHIS to implement a quarantine and testing protocol for sweet potatoes (Ipomoea batatas) that can be completed in about 6-8 months.*** The previous protocol required 18-24 months to complete. **Role:** Ms. Hurtt collected and characterized a broad spectrum of sweet potato viruses and designed experiments to determine if all of them could be detected by replica testing of infected germplasm in one growing season. Dr. Salih established the infected sweet potato germplasm *in vitro* and then returned propagations of the clones for grow out and testing in a greenhouse by Ms. Hurtt. Ms. Hurtt documented the experiments, wrote the proposal for the new protocol, and submitted it to APHIS. **Impact:** The new procedure for the quarantine and testing of sweet potato genetic resources expedites the testing and release of healthy germplasm by 12-18 months. It also reduces costs and space needs for the laboratory.

Accomplishment: ***Developed a rapid, reliable and sensitive PCR-based system to detect geminiviruses in sweet potato genetic resources.*** The PCR method can detect the geminiviruses in sweet potato plants growing in tissue culture and in greenhouse-grown plants. This method is as reliable as graft-inoculation on the indicator host *Ipomea setosa*, and is completed in two days instead of two months. The new method has a broad detection range and can be used year-round. **Role:** Ms. Hurtt initiated this project by collecting and characterizing geminiviruses, performing comparative biological assays and testing published primers using PCR. Dr. Li developed a new extraction method and designed new primers and protocols that are more sensitive and efficient

than the published ones and can detect the viruses directly in sweet potato plants. Dr. Salih provided *in vitro* plant materials. **Impact:** The PCR method has been used to detect geminiviruses in the sweet potato indexing and therapy programs. It speeds dissemination of healthy plant material to the recipients and greatly reduces costs. Dr. Li is currently using the PCR detection method to help the tissue culture program develop more efficient therapeutic methods for eradicating geminiviruses in sweet potato. The extraction method has been transferred to USDA-ARS scientists at the Plant Genetic Resources Conservation Unit in Griffin, Georgia.

EXOTIC PATHOGENS OF CITRUS (1275-22000-204-00D)

Accomplishment: ***Characterized the exotic Citrus yellow mosaic virus from India.*** The team purified the virus from infected sweet orange, cloned the genome and sequenced it fully and reintroduced the virus into sweet orange by *Agrobacterium*-mediated transformation. The ultrastructure of infected sweet orange has also been documented as well as the characteristics of insect transmission of the virus. **Role:** Dr. Hartung conceived and designed the project. Dr. Huang performed the molecular work while she was a research associate in Dr. Hartung's laboratory. Cristina Paul performed the insect transmission work at Ft. Detrick and the ultrastructure of infected plant cells was done by Dr. Brlansky using elctron microscopy. Drs. Huang and Brlansky wrote the manuscripts which were revised by Dr. Hartung. **Impact:** The *Citrus yellow mosaic virus* is a widespread and damaging virus in India, but has not yet been introduced into the United States. The complete characterization of the dsDNA virus genome combined with the ultrastructural work provides insight into the biology of this group of viruses and opens the door for potential biotechnological applications. The full genome sequence has provided the basis for PCR-based detection methods. The identification of the citrus mealy bug as the vector of the virus resolves a conflict in the literature and will contribute to disease control in the event the pathogen is introduced.

Accomplishment: ***Characterized the interaction of the sweet orange strains of Xylella fastidiosa, a select agent, with sweet orange, coffee, grapevine and periwinkle.*** Demonstrated that the sweet orange strain of *X. fastidiosa* could not only infect coffee or grapevine, but that when it did so it induced disease syndromes characteristic of other strains of *X. fastidiosa* originally isolated from these hosts. For example, the sweet orange strain of the pathogen induced Pierce's disease in grapevine, and 'Requeima do café' in coffee rather than 'grapevine or coffee variegated chlorosis'. The symptoms of these dieases are very different, and thus the symptoms of the Xylellae diseases are the result of plant reponses to the pathogen rather than to pathogenicity genes unniquely expressed by a particular strain of the pathogen. **Role:** These experiments were conceived by Dr. Hartung and Dr. Li who was then at Fundecitrus. Dr. Li performed the plant inoculations with colleagues at Fundecitrus initially and subsequently with Dr. Zhou at Beltsville. PCR assays critical to the work were developed in Dr. Hartung's laboratory. Dr. Li wrote drafts of the manuscripts which were then revised by Dr. Hartung. **Impact:** This work has demonstrated the astonishing host range of *X. fastidiosa*, and has shown in particular that the sweet orange strain may pose a threat to the viticulture industry as well as the sweet orange industry. The results of these experiments, that the symptoms induced by the pathogen are due to host responses rather than due to particular patterns of gene expression by the pathogen, have been confirmed by the full genome sequence analyses of these strains, carried out by others, which have shown a very high degree of genetic relatedness between the strains of *X. fastidiosa* and very little in the way of genes unique to particular strains.

Accomplishment: ***Developed tools for the genetic analysis of Xylella fastidiosa.*** Methods have been developed to introduce marked mutations into the genome of the bacterium and to transform the bacterium with plasmid DNA. A hybrid shuttle vector that can replicate in both *E. coli* and *X. fastidiosa* has also been developed for use in genetic complementation studies. **Role:**

Dr. Hartung conceived this line of research and has led the research effort. Dr. Qin developed the method for introducing the mutations into sweet orange strains of *X. fastidiosa* and Dr. Li has continued this work with coffee strains of *X. fastidiosa*. Dr. Qin also developed the shuttle vector and worked out the transformation protocol. Dr. Li has used the confocal microscope and with Dr. Griesbach has created images of the pathogen inside sweet orange, grapevine, and periwinkle tissue using the green fluorescent protein label. Dr. Li also developed anefficient method to localize the mutations using the full genome sequence available. Drs. Qin or Li wrote drafts of the manuscripts which were revised by Dr. Hartung. **Impact:** Full genome sequence data is now available for both the sweet orange and grapevine strains of *X. fastidiosa*, but lack of genetic tools still limits full utilization of this data. The GFP-labeled strains are proving to be very useful in characterizing in detail the location of the bacterium in infected plants.

FUTURE RESEARCH PLANS

Small Fruit Breeding, Diseases, and Physiology

For blueberry, the Fruit Laboratory breeding program will continue to screen sources of resistance, and incorporate resistances into breeding populations. Emphasis will also be placed on improving selection methods for resistance (especially the development of molecular markers). Other goals include: 1) evaluating for firmness and quality retention (sugars, acidity, flavor, etc.) especially as it impacts mechanical harvesting; 2) incorporating and evaluating a parthenocarpic trait controlled by a single recessive allele [Parthenocarpy may result in fewer pollination concerns, especially under suboptimal weather conditions, and may result in more stable yield across years]; and 3) developing germplasm with various percentages of *V. constablaei* and *V. ashei* (rabbiteye) germplasm with the goal of producing vigorous, broadly-adapted, cold-hardy *V. ashei* hybrids. The emphasis in plant disease research will include: 1) studies to identify and assemble blueberry families to be used for disease resistance work and marker-assisted selection; 2) utilization of EST and AFLP markers for determining the mode of inheritance in interspecific blueberry hybrids; and 3) investigation of the correlation of anthracnose fruit-rot resistance with fruit volatiles. Physiology/Biochemistry research will focus on evaluating the blueberry germplasm collection for fruit quality and antioxidant capacity. **For strawberry and brambles, and other small fruits**, the Fruit Laboratory breeding program will: 1) continue the well-established program for June-bearing strawberry cultivar development and germplasm enhancement with emphasis on resistance to *Colletotrichum* and *Botrytis*; 2) develop heat-tolerant everbearing strawberry cultivars; 3) develop of thornless blackberry cultivars for the Eastern U.S.; and 4) the utilize SSRs in germplasm characterization, identification, evolutionary comparisons, and marker-assisted breeding. Physiology/Biochemistry research will focus on: 1) evaluating the wild strawberry germplasm collection, the strawberry breeding program, the blackberry breeding program and lingonberry fruit for fruit quality and antioxidant capacity; 2) study the possible anticancer and antioxidant properties of berry fruits; 3) evaluate the effect of CO_2 enhancement on fruit quality and aroma compounds in strawberry.

Biotechnology/Molecular Biology of Small Fruit Crops

Future studies with blueberry will be conducted to: 1) map QTLs controlling chilling requirement and cold hardiness; 2) generate more ESTs and imprint cDNAs onto microarrays to identify genes that are upregulated or downregulated during cold acclimation; 3) map members of the dehydrin gene family and other cold acclimation-responsive genes from blueberry and determine whether any of the genes map to QTLs identified as controlling chilling requirement or cold hardiness; 4) isolate genomic clones of the dehydrin gene family and characterize their promoters; 5) make full-length clones of cold acclimation-responsive genes available for transformation to test their effects on cold hardiness; 6) explore pollen transformation as a method of generating transgenic plants; and 7) continue research to optimize conditions for shoot regeneration and transformation of commercially important blueberry cultivars. Future studies on strawberry and other small fruits will focus on: 1) the development of SSR markers for

strawberry and bramble; 2) the identification of SSR markers associated with strawberry resistance to bacterial angular leafspot disease, blackberry SSR markers associated with primocane fruiting and thornlessness, and raspberry SSRs associated with fruit color, tipping, and fall fruiting; 3) determining expression patterns for available strawberry thermo-stress response genes, 4) developing necessary antibodies for assessing protein expression of these genes; 5) developing assays for assessing the effects of elevated temperature on pollen, ovules, and runners as well as on cotyledon greening; 6) determining the influence of elevated temperature on expression of genes involved in flower and fruit production in strawberry; 7) obtaining additional EST sequence data with which to construct a small microarray for assaying the stress state of experimental plants, and with which to develop markers for a collaborative mapping project; 8) determining the mode of action of *dcHsp17.7* using *Arabidopsis* and strawberry; 9) continuing research to optimize conditions for shoot regeneration and transformation of commercially important strawberry cultivars; 10) determining the genetic stability of increased levels of disease resistance in tissue-culture induced variants of strawberry; 11) determining if RAPD markers can detect somaclonal variation following shoot regeneration/transformation and if cultural conditions and genotype influence the degree of genetic variation; and 12) conducting shoot regeneration studies on several strawberry cultivars and progeny of crosses between the cultivars to identify a genetic basis for regeneration. Molecular markers linked to high frequency shoot regeneration will be developed.

Small Fruit Crop Sustainable Production Systems

Future research includes: 1) Evaluating cultural practices for control of the replant disorder strawberry black root rot; 2) investigating alternative mulches for sustainable weed control in small fruit production systems; 3) testing plant growth regulators for potential applications in small fruit crops, including regulating strawberry runnering, and suppressing flower bud initiation in blueberry; investigating additional methods for growing highbush blueberry on upland sites including evaluating *V. elliottii* selections as rootstocks; 4) determining uptake, internal distribution and seasonal cycling of nitrogen in strawberry, for improving fertilization management, and identifying nitrogen efficient genotypes; 5) evaluating a collection of *Elaeagnus umbellata* clones for commercial fruiting potential; 6) conducting analyses of antioxidants in Autumn Berry fruit samples from different small fruit genotypes; and 7) evaluating the effect of preharvest and postharvest conditions on fruit quality and phytonutrient content in berry crops.

Citrus Diseases

The Citrus Exotic Diseases program will conduct further studies using confocal microscopy and GFP labeled strains of *X. fastidiosa* to study colonization of primary and secondary hosts of the bacterium. The program will also include: 1) completing the development of a real-time PCR based detection method for *Liberobacter* spp., the causal agent for citrus greening disease; 2) studying the interactions between *X. fastidiosa* and endophytic bacteria in planta; 3)

characterizing the populations of *X. fastidiosa* present in two significant regions, Costa Rica and Puerto Rico; and 4) maintaining the collection of exotic pathogens of citrus with detailed inventories and moving the collection into a planned new greenhouse complex.

Plant Germplasm Quarantine Office

The PGQO will:1) continue to perform quarantine activities necessary to process germplasm of sweet potatoes, potatoes, sugarcane., pome, stone and small fruits, forage and turf grasses, and miscellaneous tropical crops and woody ornamentals; 2) determine the etiology of unknown virus-like diseases intercepted in quarantined imports, and characterize the causal agents to improve the indexing methods used by PGQO; 3) expand the use of molecular-based testing for pathogens by applying or adapting approved techniques or developing molecular techniques for the detection of new viroids and viruses in quarantine crops; 4) integrate the RT-PCR assays for detection of foveaviruses, BRV, ScYLV, and other viruses into indexing program; 5) develop new methods that can be used to screen *in vitro* plantlets for pathogens and utilize therapeutic *in vitro* treatments for the elimination of pathogens; 6) develop a new Quarantine Information System (QIS) for tracking incoming material, testing progress, and shipment of released material; and 7) synchronize accession and order data between QIS and the Germplasm Resources Information Network (GRIN).

Proposed New Research Initiatives:

Integrated small fruit crop management

Small fruit crops are high-value/high input cropping systems. With increasing public concern over pesticide use, and fewer chemicals receiving registration for pest control, disease and insect pest management continues to be a growing concern to fruit producers. The Fruit Laboratory has established programs in small-fruit breeding, pathology, and physiology that all seek to improve the sustainability of small fruit production. **A new SY position in insect biocontrol**, focusing on IPM of insect pests important to the small fruit industry, would add to the existing team in making the Fruit Laboratory a leader in developing integrated management systems.

Tissue Culture Program for the Plant Germplasm Quarantine Office

Tissue culture plays a central, vital role in all germplasm testing programs run by the Plant Germplasm Quarantine Office. It is required for both receipt and shipment of accessions, backup security for accessions during the testing period, propagation of special plant materials needed for testing, and increasingly, for the development and implementation of large scale therapeutic projects aimed at eliminating viral pathogens from irreplaceable germplasm. A new SY position focused on plant tissue culture and plant pathology is immediately required to preserve, strengthen and promote the programs of the PGQO.

Virologist for the Exotic Pathogens of Citrus Project

The exotic pathogens of citrus project is a unique and well established research endeavor, with a long established program looking over the horizon at emerging exotic pathogens that threaten the well being of the citrus industry. It is a project with both high fixed overhead costs and high impact, and is uniquely positioned to address current concerns about exotic/emerging pathogens. The citrus industry would benefit, and ARS would get a greater return on its fixed research costs, if a **new SY position** was created focusing on exotic virus diseases of citrus.


ADMINISTRATIVE ISSUES
SCIENTISTS' CONTRIBUTIONS
FINANCIAL

Annual Resource Management Plan System
Annual Operating Plan

Version FY2003C

Account Code: 401-1275-111
Mode Code: 03-10-12-1275-11-00-00-00
MU Name: FRUIT LABORATORY
Location Name: Plant Sciences Institute
Area Name: BELTSVILLE AREA
Agency: 03

This MU occupies both Federal and Non-Federal space

Distr. of Resources	Pos Cat	Obj Cls	Prior Year Dollars	FTE	Current Year Dollars	FTE	Difference Dollars	FTE	CRIS/IRC Distribution	
Personal Services									1275-21000-157-00D	16.01%
Scientific Effort									1275-21000-159-00D	10.76%
Research Scientist	1	1000	1,011,688	9.00	1,013,958	9.00	2,270		1275-21000-160-00D	5.47%
Service Scientist	4	1000	442,316	5.00	443,604	5.00	1,288		1275-21000-163-00D	6.45%
Support Effort									1275-21220-181-00D	22.30%
Non Perm Res/Serv Sci.	2	6000	189,704	4.00	56,473	1.25	-133,231	-2.75	1275-21220-186-00D	28.93%
Support Scientist	3	6000	288,199	4.00	298,489	4.00	10,290		1275-22000-204-00D	10.08%
Technician/Aid/Asst	5	6000								
Specialist	6	6000	70,560	1.00	77,364	1.00	6,804			
Technician/Aid(Eng.& Sci.)	7	6000	853,128	23.40	968,682	18.00	115,554	-5.40		
Trades & Crafts	8	6000	164,801	4.00	122,180	3.00	-42,621	-1.00		
Admin. Support	9	6000	86,431	2.00	96,093	2.00	9,662			
(Other)		6000	49,902	24.30	77,572	4.00	27,670	-20.30		
Overtime										
Premium Pay										
Promotion/Award/QSI/Merit Pay			62,000		74,000		12,000			
PERSONNEL SUBTOTAL			3,218,729	76.70	3,228,415	47.25	9,686	-29.45		
Travel of Persons		2100			62,000		62,000			
Transportation		2200			21,500		21,500			
Rent, Comm., Utilities		2300								
Printing & Reproduction		2400								
Contract & Other Services		2500			25,000		25,000			
Repair & Maintenance		2530			33,300		33,300			
Research Support Agreement		2554		2.17	106,581	2.17	106,581			
Supplies and Materials		2600			389,188		389,188			
Equipment		3100			30,000		30,000			
Land & Structure		3200								
Extramural		4000			14,145		14,145			
ALL OTHER - SUBTOTAL				2.17	681,714	2.17	681,714			
TOTAL			3,218,729	78.87	3,910,129	49.42	691,400	-29.45		
BASE FUNDS					3,914,628		3,914,628			
Management Criteria										
Percent in Salaries						65.57%		65.57%		
Support Years per SY				4.48		2.38		-2.10		
Total Dollars per SY					361,439		361,439			
Bench Dollars per SY					283,283		283,283			
Discretionary Funds per SY			-229,909		40,335		270,244			
Percent Discretionary						11.16%		11.16%		
										100.00%

REMARKS: IRC = $1,094,183 SRC = $55,833 Recruitment Incentives under Demo Project = $0
Biotech: $-35,299; Soft Funds: $10,000 Valent BioSciences; HQ's PD $30,800

FUNDHOLDER - Freddi Hammerschlag, RL DATE APPROVING OFFICIAL DATE TELEPHONE NO.

ADMINISTRATIVE ISSUES

SCIENTISTS' CONTRIBUTIONS

Multi-Year Analysis FY2004

Instutite: PSI
Managment Unit: Fruit Laboratory

	FY2004		FY2005		FY2006
Total Salaries from FY-2004 ARMPS	$3,154,415		$3,171,302		$3,252,170
Inflation Factor		2.55%		2.55%	
IRC Costs	$1,068,860		$1,091,306		$1,114,223
Inflation Rate		2.10%		2.10%	
Total Costs	$4,223,275		$4,262,608		$4,366,393
Increase $$			$39,333		$103,786
# of SY's	14.0		14.0		14.0
Outyear Reduction Factor			$2,809		$7,413
$/SY	$40,335		$37,526		$30,112

[1] HQ funded postdoc FY04, yr. 2, W. Li

Annual Resource Management Plan System
Position Staffing Plan
BELTSVILLE AREA
Plant Sciences Institute

03-10-12-1275-11-00-00-00
Fruit Laboratory

Version FY2003C
401-1275-111

Employee Name	Position Number	Position Title	Pay Plan & Grade (FPL)	Status	FTE	Salary	Footnote	EOD Date/ RA Exp Date
Hammerschlag, Freddi	1B3556	Supvy Plant Physiologist	GS- 15 (0)	PFT	1.00	138,390	L1	
Hartung, John	1B3813	Supvy Res Plant Pathologist	GS- 15 (0)	PFT	1.00	152,619	L1	
Kinard, Gary	4B861	Plant Pathologist	GS- 15 (0)	PFT	1.00	92,107	Z1	
Wilson, Andrew	7B9590	Agric Sci Res Tech	GS- 8 (9)	PFT	1.00	50,422	Z1	
VACANT	8B8158	Gardener (Tractor Oper/MVO)	WG- 5 (6)	PFT	1.00	40,080	Z1	10/5/2003
Goodkind, David	8B871	Gardener (Tractor Oper/MVO)	WG- 5 (5)	PFT	1.00	40,655	M1 Z1	
Deyorio, John	8B869	Gardener (Tractor Oper/MVO)	WG- 4 (5)	PFT	1.00	41,445	M1 Z1	
Hurtt, Suzanne	4B876	Plant Pathologist	GM- 13 (0)	PFT	1.00	86,334	L1 Z1	
Turner, Roy	7B878	Agric Sci Res Tech	GS- 9 (9)	PFT	1.00	67,410	M1 Z1 N4	
Loschinkohl, Cerinda	7B9426	Biological Sci Lab Tech	GS- 9 (9)	PFT	1.00	56,653	Z1	
Cartier, Tim	0B71	Biological Sci Lab Tech	GS- 4 (4)	TPT	0.30	8,044	Z10 Z1	
Salih, Sarbagh	2B9661	Horticulturist	GS- 12 (12)	TFT	0.25	21,861	F Z1	12/31/2003
Davis, Gary	7B9592	Biological Sci Lab Tech	GS- 8 (9)	PFT	1.00	57,185	Z1	
Anderson, Gregory	0B141	Biological Sci Aid	GS- 3 (3)	TPT	0.30	6,920	Z1	
Raymond Mock	4B8094	Plant Pathologist	GS- 12 (0)	PFT	1.00	80,841	Z1	
Whitted, Katreena	0B8176	Biological Sci Aid	GS- 3 (3)	TPT	0.30	4,490	Z1 Z8	
Donnelly, Kevin	7B8070	Agric Sci Res Tech	GS- 9 (9)	PFT	1.00	63,098	M1 Z1	
Kim, Tom	7B9591	Biological Sci Lab Tech	GS- 8 (9)	PFT	1.00	58,327	Z1	
Li, WenBin	2B121	Res Plant Pathologist	GS- 11 (0)	TPT	1.00	34,612	Z3 E2	8/28/2004
Paul (Gouin) Cristina	3B9587	Horticulturist	GS- 11 (11)	PFT	1.00	74,389	T3 N4	
Ross, Tiara	0B6	Biological Sci Lab Tech	GS- 4 (4)	TFT	0.30	9,765	Z9	
King, Steven	6B9589	IT Specialist (Data Mgmt)	GS- 11 (11)	PFT	1.00	77,364	Z1 T2	
Cabrera-Woscek, Julia	7B4082	Biological Sci Lab Tech	GS- 7 (9)	PFT	1.00	46,446		
Li, Ruhui	4B879	Research Plant Pathologist	GS- 12 (0)	PFT	1.00	84,705	Z1	
VACANT	7B8195	Biological Sci Lab Tech	GS- 8 (8)	PFT	1.00	52,000	Z1	
Rowland, Lisa	1B3195	Research Geneticist (Plants)	GS- 14 (0)	PFT	1.00	124,288	N3	
Ogden, Elizabeth	3B8198	Horticulturist	GS- 11 (11)	PFT	1.00	74,510	M1 M2	
Labega, Adrienne	7B8225	Agric Sci Res Tech (Plants)	GS- 7 (9)	PFT	1.00	54,128		
Slovin, Janet	1B4897	Molecular Biologist	GS- 14 (0)	PFT	1.00	125,265		
Murphy, Andrea	7B7716	Biological Sci Lab Tech	GS- 8 (8)	PFT	1.00	45,174		10/5/2003
Hammann, Amanda	0B295	Biological Sci Aid	GS- 3 (3)	TPT	0.30	2,913		
Ehlenfeldt, Mark	1B9315	Research Geneticist	GS- 14 (0)	PFT	1.00	120,943	Z2	
Martin, Jr., Robert	7B8193	Biological Sci Lab Tech	GS- 6 (9)	PFT	1.00	42,663	Z2	
Wang, Shiow	4B9026	Plant Physiologist	GS- 13 (0)	PFT	1.00	99,617		
Kim, Sue	0B376	Biological Sci Aid	GS- 3 (3)	TIN	0.30	6,313		
VACANT	1B3200	Research Plant Pathologist	GS- 12 (0)	PFT	1.00	79,540	L1	10/5/2003
Axum, Mchezaji	7B4091	Biological Sci Lab Tech	GS- 7 (7)	PFT	1.00	49,367		
Lewers, Kimberly	1B9455	Research Geneticist (Plants)	GS- 12 (0)	PFT	1.00	80,827		
Enns, John	3B3210	Horticulturist	GS- 11 (11)	PFT	1.00	76,905		
Rappaport (Salazar) Kate	7B3207	Agric Sci Res Tech (Plants)	GS- 9 (9)	PFT	1.00	77,067	M1 M2	
Garrett, Sam	7B3209	Agric Sci Res Tech (Plants)	GS- 8 (9)	PFT	1.00	55,454		
VACANT	0B9370	Biological Sci Aid	GS- 3 (3)	TIN	0.15	2,800		

Position Staffing Plan
BELTSVILLE AREA
Plant Sciences Institute

Version FY2003C
401-1275-111

03-10-12-1275-11-00-00-00
Fruit Laboratory

Employee Name	Position Number	Position Title	Pay Plan & Grade (FPL)	Status	FTE	Salary	Footnote	EOD Date/ RA Exp Date
Black, Brent	1B9580	Plant Physiologist	GS- 12 (0)	PFT	1.00	92,594		
Fordham, Ingrid	3B3212	Horticulturist	GS- 11 (11)	PFT	1.00	72,685		
Edmonds, Philip	7B8945	Agric Sci Res Tech (Plants)	GS- 8 (8)	PFT	1.00	59,403	M1 M2	
Ray, Stephanie	7B8017	Biological Sci Lab Tech	GS- 8 (8)	PFT	1.00	51,450		
VACANT	0B9557	Biological Sci Aid	GS- 3 (3)	TIN	0.30	10,887		
Brown, Candice	0B9558	Biological Sci Aid	GS- 3 (3)	TIN	0.30	3,339	Z5	
Peralta, Ernalyn	0B8241	Biological Sci Aid	GS- 3 (3)	TIN	0.30	11,821		
Jenkins, Kendra	9B3213	Support Services Asst (OA)	GS - 7 (7)	PFT	1.00	59,893		
Butler, Darlene	9B3217	Office Automation Asst	GS- 5 (5)	PFT	1.00			
Strandberg, Nichole	0B501	Office Automation Clerk	GS- 3 (3)	TPT	0.30			
					43.40	2,926,008		

Non Federal FTE

Type	FTE
Research Support Agreement	2.17
Support Service Contract	0.00
Donated	0.00
Revolving Funds	0.00
Other	0.00
	2.17

Footnotes:

E2 -Research Associate - Headquarters Approved, some/all Locally Funded.
L1 -Level I SY (i.e. Lead Scientist/Project Leader).
M1 -Exigency employee must report to or remain on work site regardless of extreme weather or other emergency condition.
M2 -Exigency employee must report to or remain on work site for budget shutdowns.
N3 -Radiological Safety Officer (RSO)
N4 -Collateral Duty Safety Officer (CDSO)
T2 -Technical IT and telecommunications contact(s) responsible for local area network administration, e-mail management, and voice, video, satellite and radio telecommunications
T3 -Person responsible for maintaining unit web site
Z1 -Worksite Building 580
Z2 -Worksite Chatsworth, NJ
Z3 -NTE 08/28/04 (Li, W.)
Z5 -NTE 07/24/04 (Brown, C.)
Z8 -NTE 05/18/04 (Whitted, K.)
Z9 -NTE 11/2/04 (Ross, T.)
Z10 -NTE 09/30/04 (Chartier, T.)

ADMINISTRATIVE ISSUES

SCIENTISTS' CONTRIBUTIONS

Safety and Health Report

A Safety, Occupational Health, and Environmental Section staff member conducted a walk through inspection of all Fruit Laboratory facilities on October 17, 2003. The minor violations noted were promptly corrected. The yearly chemical Survey was conducted on February 25, 2004, and minor violations were corrected.

Previous Review Team

Dr. James J. Luby - Chair
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Department of Horticultural Science
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E-mail: lubyx001@maroon.tc.umn.edu

Dr. Gloria Moore
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1143 Fifield Hall
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Dr. Robert Linderman
USDA, ARS, PWA
Horticultural Crops Research Lab
3420 NW Orchard Avenue
Corvallis, OR 97330
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4700 River Road
Riverdale, MD 20737
Tel: 301-734-5216; Fax: 301-734-4300

Response to Recommendations from Previous In-Depth Review

Response to recommendations from Fruit Laboratory In-Depth Review of November 16-19, 1999

1. **Issue:** *Selection of a new permanent RL must be expedited to sustain the current level of leadership momentum and the new RL will need to have a broad horticultural understanding and leadership.*
   Response. The position was advertised and a committee was set up to evaluate the candidates. An internal candidate (Dr. Freddi Hammerschlag) was rated the highest and selected as the new RL. Because of financial problems in the Laboratory, the vice Zimmerman position was abolished.

2. **Issue:** *SYs want a better understanding of budgeting to have a better concept of possibilities and limitations for expenditures.*
   Response: The ARMPS is now shared with all SYs.

3. **Issue:** *There is a concern about commitments of safety by ARS Management. Safety is a top priority in ARS.*
   Response: Showers in Building 580 are now available to ARS staff. Peeling lead paint in the FL's greenhouse was addressed. Asbestos in the greenhouse was encased to reduce exposure. The FL greenhouses, however, were destroyed by the tornado of 2001 and the FL staff have shifted much of their greenhouse research to plastic hoop houses.

4. **Issue:** *The PGQO has grown beyond what was initially envisioned for the ARS program. It would be nice to have all staff, including the Unit Leader, located in Building 580.*
   Response: The growth of the program has been reversed by staff attrition and all the program effort is being consolidated in Building 580. The research program of the Unit Leader will not be moved to 580. All are excited about the completion of laboratory and greenhouse facilities which should be turned over to ARS by June 2004. When this occurs, all PGQO activities will be located at Building 580. The staff has already moved into new office space in 580. The BA office is constantly communicating with APHIS Administrators about the need for space in 580. The pesticide filling/washdown facility has been completed. A new tractor barn and storage facility has been built by ARS at the site of the pome orchards within the 580 complex. New state-of-the-art equipment has being obtained for this group.

5. **Issue:** *The Review Team recommended hiring a Plant Pathologist with fungal expertise for Chatsworth, a small fruit virologist with attention to blueberries, cranberries, brambles and strawberries, and a fungal Pathologist to replace John Maas once he retires.*
   Response: Dr. Jim Polashock was hired to fill the fungal Pathologist position in Chatsworth

in conjunction with the construction of a new Plant Pathology Laboratory. Funds to fill the proposed small fruit virology position are not available. The recruitment of a Plant Pathologist to replace John Maas is in progress.

6. **Issue:** *The research program of Dr. Hokanson is highly thought of by customers, particularly the development of cultivars with improved disease resistance. The Review Team believes the split in the position should be revised to de-emphasize molecular genetics component in keeping with customers' needs and expectations for products from the breeding program.*
   Response: Dr. Hokanson's research project was recognized as very significant. BARC administration appreciates the concern the team had for recommending a change in direction of research away from molecular genetics but realizes the need to continue the molecular genetics approach to develop molecular markers which should enhance the breeding program. Dr. Hokanson has since been replaced by Dr. Kim Lewers who maintains both a strong breeding program and strong molecular marker program.

7. **Issue:** *The research program of Dr. Ehlenfeldt is commended for developing improved screening methods for disease resistance, but he is encouraged to develop blueberry cultivars of commercial significance. Also, the American Blueberry Council would like to see a protocol for distribution of plant material so that appropriate testings stations have equal and timely access to the material and all plant material distributed from the program is tested for viruses and phytoplasma.*
   Response: A protocol for distribution of plant materials has been developed and distributed. The lines produced by Dr. Ehlenfeldt will be sent to those who want and request materials. The most advanced plant material is inspected through the NJ State Inspection Program before distribution. The Fruit Lab requires additional support staff to be able to test all seedling and selection material prior to distribution.

8. **Issue:** *The use of municipal waste products in blueberry production are of concern. The committee questions whether applying these composts to crops that are grown on minor acreage and are directly consumed by humans provides a realistic and safe use of municipal waste compost. The need to include more economic impacts, particularly on the sustainable systems is needed.*
   Response: Dr. Black is heading up this aspect of the research program. Candidate composts and coal combustion byproducts used in our research are analyzed for elemental content and compared against standards set by the Environmental Protection Agency for agricultural use of sewage sludge (A Guide for Land Appliers on the Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge, 40 CFR Part 503). Reports to growers that may be potential users of this technology are cautioned of the potential risks of waste product utilization. The economics of this approach are also being evaluated.

9. **Issue:** *The PGQO has made great strides in supplying service to this community. Suzanne Hurtt, Dr. Waterworth and other staff are commended for improvements in indexing procedures in several programs, including sugarcane, potato, rice and pome and stone fruits, in response to customer needs that increased productivity.*
   Response: These programs will continue to improve and to provide service to our customers. Dr. Kinard and more recently, Dr. Ruhui Li, and Dr. Sarbagh Salih and Mr. Ray Mock (replaced Dr. Waterworth) have been pursuing more molecular and tissue culture approaches for detecting and eliminating plant pathogens from introduced germplasm. Unfortunately, both Dr. Salih and her technician Adrea Murphy resigned in December 2003 leaving the tissue culture program on hold. Recruitment to replace Dr. Salih is under consideration. Mr. Steven King has provided excellent data management and computer support services to both PGQO and the Fruit Laboratory.

Brent L. Black
Research Plant Physiologist - Small Fruits

Research: Research focuses on developing and evaluating production practices and systems for sustainable small fruit production, investigating physiological factors influencing the productivity of small fruit crops in sustainable production systems, and providing opportunities for diversification by developing alternative production practices and identifying alternative fruit crops. Current research projects include comparing the sustainability (economics, consumer preference, efficiency, environmental impacts) of three strawberry production systems; investigating the efficacy of prohexadione-Ca for suppressing runners of 'Chandler' strawberry plants in a cold-climate annual hill system; evaluating industrial byproducts as substrates or soil amendments for growing highbush blueberry on upland sites; testing cultural practices for control of strawberry black root rot; evaluating management practices and mechanical harvesting of *Elaeagnus umbellata*. Future plans include testing plant growth regulators for potential applications in small fruit crops, including regulating strawberry runnering, and suppressing flower bud initiation in blueberry; investigating additional methods for growing highbush blueberry on upland sites including evaluating *V. elliottii* selections as rootstocks; determining uptake, internal distribution and seasonal cycling of nitrogen in strawberry, for improving fertilization management, and identifying nitrogen efficient genotypes; and evaluating a collection of *Elaeagnus umbellata* clones for commercial fruiting potential.

Publications (2000-present):

Peer-Reviewed Journal Articles:

Black, B.L., C. Parmentier-Line, L.H. Fuchigami, and G.D. Coleman. 2001. Ecotypic and genetic variation in poplar bark storage protein accumulation. Tree Physiol. 21:1289-1297.

Black, B.L., L.H. Fuchigami, and G.D. Coleman. 2002. Partitioning of nitrate assimilation among leaves, stems and roots of poplar. Tree Physiol. 22:717-724.

Black, B.L. and R.H. Zimmerman. 2002. Mixtures of coal ash and compost as substrates for highbush blueberry. J. Amer. Soc. Hort. Sc. 127:869-877.

Black, B.L., J.M. Enns, and S.C. Hokanson. 2002. A comparison of temperate-climate strawberry production systems using eastern genotypes. HortTechnology 12:670-675.

Black, B.L., H.J. Swartz, P. Millner, and P. Steiner. 2003. Pre-plant crop rotation and compost amendments for improving raspberry establishment. J. American Pomological Soc. 57:149-156.

Hokanson, S.C., F. Takeda, J.M. Enns, and B.L. Black. 2004. Influence of cold storage duration on strawberry runner tip viability and field performance. HortScience. (In press)

Black, B.L. 2004. Prohexadione-Calcium decreases autumn runners and advances branch crowns of 'Chandler' strawberry in a cold-climate annual production system. J. Amer. Soc. Hort. Sci. (In Press)

Conference Proceedings:

Black, B.L. and S.C. Hokanson. 2000. Current Status and Future Opportunities in the U.S. Strawberry Industry. Proceedings of the NATO CCMS Workshop on New Agricultural Technologies. Beltsville, Maryland, May 9, 2000.

Black, B.L., M.J. Bukovac, and M. Stopar. 2000. Intra-spur fruit competition and position influence fruit size at harvest and response to chemical thinning agents in spur-type 'Delicious' apple. Acta Hort. 527:119-125.

Black, B.L. and R.H. Zimmerman. 2002. Industrial and municipal by-products as substrates for highbush blueberry production. Acta Hort. 574:267-272.

Black, B.L., J.M. Enns, and S.C. Hokanson. 2002. Advancing the matted-row strawberry production system. Strawberry Research to 2001: Proc. 5th North Amer. Strawberry Conf. pp. 112-115.

Fordham, I.M., R.H. Zimmerman, B.L. Black, B.M. Clevidence, and E.R. Wiley. 2004. Autumn olive: A potential alternative crop. Acta Hort. (In press)

Collaborators:

James Ballington, North Carolina State University. Blueberry production practices, screening of blueberry selections for upland soil adaptation.

Beverly Clevidence, USDA-ARS Diet and Human Performance Lab, Beltsville, MD; Penelope Perkins Veazie USDA-ARS Genetics and Production Research Unit, Lane, OK; Dr. Joseph Scheerens, Ohio State University, Wooster, OH. Analysis of *Elaeagnus umbellata* fruit for biochemical components with specific interest in lycopene content.

Cathleen Hapeman and Ali Sadeghi, USDA-ARS Environmental Quality Lab, Beltsville. Collaboration in quantifying the impacts of small fruit production practices on the environment, including erosion, runoff and leaching of nutrients and pesticides.

John Lea-Cox, Natural Resource Sciences and Landscape Architecture Dept., University of Maryland, College Park. Collaboration on determining fate of fertilizer nutrients in strawberry production systems.

Pat Millner, USDA-ARS Sustainable Agriculture Systems Lab, Beltsville; Jim Hancock and Annemiek Schilder, Michigan State University; Marvin Pritts, Cornell University. Multi-state collaborative project to evaluate non-chemical methods for controlling strawberry Black Root Rot.

Harry Swartz, Natural Resource Sciences and Landscape Architecture Dept., University of Maryland, College Park. Collaboration on finding cover crops and alternative mulches for use in small fruit production systems.

Mark K. Ehlenfeldt
Research Geneticist - Small Fruits

Research: Research program focuses on: 1) identifying sources of resistance to fungal diseases, including anthracnose fruit-rot (*Colletotrichum gloeosporioides*) and mummy berry (*Monilinia vaccinii-corymbosi*) and incorporating these resistances into advanced selections; 2) developing improved screening procedures to select for resistance to diseases, with emphasis on developing seedling screening methods; and 3) producing germplasm with new combinations of desired genes to produce material with broad adaptation, greater disease resistance, good yield, improved fruit quality, suitability for mechanical harvesting, short harvest interval, and good storage ability. Dr. Ehlenfeldt's current and future research includes: 1) further screening of sources of resistance, incorporation of resistances into breeding populations, and improving selection methods for resistance (especially the development of molecular markers with Dr. J. Polashock); 2) evaluating firmness and quality retention (sugars, acidity, flavor, etc.) in highbush blueberry cultivars especially as it impacts mechanical harvesting; 3) incorporating and evaluating a parthenocarpic trait controlled by a single recessive allele. Parthenocarpy may result in fewer pollination concerns, especially under suboptimal weather conditions, and may result in more stable yield across years; 4) developing germplasm with various percentages of *V. constablaei* and *V. ashei* (rabbiteye) germplasm with the goal of producing vigorous, broadly- adapted, cold-hardy *V. ashei* hybrids (with Dr. L. Rowland). The resulting germplasm from these projects will be incorporated into the co-operative germplasm and cultivar development program supported by the Fruit Laboratory.

Publications (2000 - Present):

Peer-Review Journal Articles:

Ehlenfeldt, M.K., N. Vorsa, and A.D. Draper. 2000. 'Chanticleer' highbush blueberry. HortScience 35:780-782.

Ehlenfeldt, M.K. and A.W. Stretch. 2000. Mummy berry blight resistance in rabbiteye blueberry cultivars. HortScience 35:1326-1328.

Stretch, A.W. and M.K. Ehlenfeldt. 2000. Resistance to the fruit infection phase of mummy berry disease in highbush blueberry cultivars. HortScience 35:1271-1273.

Stretch, A.W., V. Brewster, M.K. Ehlenfeldt, N. Vorsa, and J. Polashock. 2001. Resistance of diploid *Vaccinium* species to the fruit rot stage of mummy berry disease. Plant Dis. 85:27-30.

Ehlenfeldt, M.K. 2001. Self- and cross-fertility in recently released highbush blueberry cultivars. HortScience 36:133-135.

Ehlenfeldt, M. K. and A.W. Stretch. 2001. Resistance to blighting by *Monilinia vaccinii-corymbosi* in diploid and polyploid *Vaccinium* species. HortScience 36:955-957.

Ehlenfeldt, M.K. and R.L. Prior. 2001. Oxygen Radical Absorbance Capacity (ORAC) and phenolic and anthocyanin concentrations in fruit and leaf tissues of highbush blueberry. J. Agric. and Food Chem. 49:2222-2227.

Duy, J.C., W. Kalt, R.L. Prior, M.K. Ehlenfeldt, and S.P. Vander Kloet. 2001. Intraspecific and interspecific variation in anthocyanins, phenolics, and antioxidant capacity among genotypes of lowbush and highbush blueberries. J. Agric. and Food Chem. 49:4761-4767.

Stretch, A.W., M.K. Ehlenfeldt, and V. Brewster. 2001. Enhancement of *in vitro* conidia production by *Monilinia vaccinii-corymbosi* (Reade) Honey by cellulose acetate membranes. HortScience 36:1290-1291.

Ehlenfeldt, M.K. and R.B. Martin Jr. 2002. A survey of fruit firmness in highbush blueberry and species-introgressed blueberry cultivars. HortScience 37:386-389.

Ehlenfeldt, M.K. 2003. Investigations of metaxenia in northern highbush blueberry (*Vaccinium corymbosum* L.) cultivars. J. Amer. Pom. Soc. 57:26-31.

Ehlenfeldt, M. K. 'Elliott' highbush blueberry. 2003. J. Amer. Pom. Soc. 57:2-6.

Rowland, L.J., M. Smriti, A. Dhanarah, M. K. Ehlenfeldt, and J.P. Slovin. 2003. Development of EST-PCR markers for DNA fingerprinting and mapping in blueberry (*Vaccinium* section *Cyanococcus*). J. Amer. Soc. Hort. Sci. 128:682-690.

Arora R., L.J. Rowland, E.L. Ogden, A.L. Dhanaraj, C.O. Marian, M.K. Ehlenfeldt, and B. Vinyard. 2004. Dehardening kinetics, bud development, and dehydrin metabolism in blueberry (*Vaccinium* spp.) cultivars during deacclimation at constant, warm temperatures. J. Amer. Soc. Hort. Sci. (In press)

Conference Proceedings:

Ehlenfeldt, M.K. and A.W. Stretch. 2002. Identifying sources of resistance to mummy berry and anthracnose in highbush, rabbiteye, and species germplasm. Acta Hort. 574:63-70.

Ehlenfeldt, M.K. 2002. Postharvest research and technology in *Vaccinium*. Acta Hort. 574:31-38.

Ehlenfeldt, M.K., L. J. Rowland, and R. Arora. 2003. Bud hardiness and deacclimation in blueberry cultivars with varying species ancestry : flowering time may not be a good indicator of deacclimation. Acta Hort. 626:39-44.

Ehlenfeldt, M.K. 2004. Fruit Firmness and holding ability in highbush blueberry - implications for mechanical harvesting. Small Fruit Review - Proc. 9th North American Blueberry Research & Extension Workers Conference. (In press)

Invited Reviews:

Ehlenfeldt, M.K. 'Elliott' highbush blueberry. 2003. J. Amer. Pom. Soc. 57:2-6.

Cultivar Releases:

'Hannah's Choice' highbush blueberry. 2000.

'Cara's Choice' highbush blueberry. 2000.

Collaborators:

Dr. John Clark, University of Arkansas, Fayetteville, AR for collaborative breeding program to produce seedling material for Arkansas utilizing adapted highbush and rabbiteye germplasm.

Dr. Chad Finn, USDA-ARS-NWCSFR, Corvallis, OR for collaborative breeding program to test material across diverse locations and to generate processing-type selections.

Dr. Scott NeSmith, University of Georgia, Griffin, GA for collaborative breeding program to produce seedling material for Georgia utilizing recently identified selections that possess high levels of fruit firmness, and to produce seedling material to develop early-ripening rabbiteye cultivars utilizing crosses of *V. constablaei* and rabbiteye germplasm.

Dr. Sam Vander Kloet, Acadia University, Wolfville, Nova Scotia, Canada for collaborative project to incorporate native and exotic species germplasm into cultivated material.

Dr. Nick Vorsa, Rutgers University, Chatsworth, NJ for a collaborative program to identify sources of disease resistance in diploid and polyploid *Vaccinium* germplasm.

Freddi A. Hammerschlag, Research Leader
Research Plant Physiologist - Plant Biotechnology

Research: Provides leadership for all research programs in the Fruit Lab. Principal research focuses on enhancement of blueberry and strawberry through modification of the plant genome. Current research involves: developing optimum conditions for gene delivery, selection, and regeneration of transgenics of several important strawberry and blueberry cultivars developed for the eastern United States; utilizing transformation technologies to introduce cold tolerance genes into elite blueberry cultivars; identifying disease resistance genes for use in the improvement of blueberry and strawberry, and developing in vitro disease resistance screening methods for elite strawberry cultivars. Future research will focus on: continuing research to optimize conditions for shoot regeneration and transformation of commercially important blueberry and strawberry cultivars; determining the genetic stability of increased levels of disease resistance in tissue-culture induced variants of strawberry; determining at the molecular level the degree of somaclonal variation that occurs during the shoot regeneration/transformation processes and if cultural conditions and genotype influence the degree of variation; and conducting shoot regeneration studies on several strawberry cultivars and progeny of crosses between the cultivars to identify a genetic basis for regeneration. Molecular markers linked to high frequency shoot regeneration will be developed.

Publications (2000-present)**:**

Peer-Reviewed Journal Articles:

Cao, X. and F.A. Hammerschlag. 2000. Improved shoot organogenesis from leaf explants of highbush blueberry. HortScience 35:945-947.

Liu, Q., J. Ingersoll, L.D. Owens, S. Salih, R. Meng, and F.A. Hammerschlag. 2001. Response of transgenic 'Royal Gala' apple (*Malus* x *domestica* Borkh.) shoots carrying a modified cecropin MB39 gene, to *Erwinia amylovora*. Plant Cell Rep. 20:306-312.

Ainsley, P., F.A. Hammerschlag, T. Bertozzi, G. Collins, and M. Sedgley. 2001. Regeneration of almond (*Prunus dulcis* Mill.) from immature seed cotyledons. Plant Cell Tiss. Organ Cult. 67:221-226.

Zemanek, A.B., K. Tae-Soek, J. Thimmapuram, F.A. Hammerschlag, and S.S. Korban. 2002. Changes in β-1,3 glucanase mRNA levels in peach in response to treatment with pathogen culture filtrates, wounding, and other elicitors. J. Plant Physiol. 159:887-889.

Cao, X., F.A. Hammerschlag, and L. Douglass. 2002. A two-step pretreatment significantly enhances shoot organogenesis from leaf explants of highbush blueberry cv. Bluecrop. HortScience 37:819-821.

Cao, X., I. Fordham, L. Douglass, and F.A. Hammerschlag. 2003. Sucrose level influences micropropagation and gene delivery into leaves from in vitro propagated highbush blueberry shoots. Plant Cell Tissue Organ Cult. 75:255-259.

Hammerschlag, F.A. 2003. In vitro inhibitory activity of antimicrobial peptides cecropin, alpha-thionin DB4, gamma thionin RsAFP1 against several pathogens of strawberry and highbush blueberry. HortScience (In press).

Conference Proceedings:

Hammerschlag, F.A., Q. Liu, R.H. Zimmerman, and P. Gercheva. 2000. Generating apple transformants free of *Agrobacterium tumefaciens* by vacuum infiltrating explants with an acidified medium and with antibiotics. Acta Hort. 530:103-111.

Garces, S., F.A. Hammerschlag, J.L. Maas, M. Koch-Dean, and B. Smith. 2002. Increased resistance to *Colletotrichum acutatum* is exhibited by leaf explant regenerants derived from several strawberry cultivars. Proc. North Amer. Strawberry Conf. 5:54-57.

Hammerschlag, F.A. and P. Saxena. (eds.). 2003. Biotechnology of Horticultural Crop Improvement: Achievements, Opportunities and Limitations. Acta Hort. 625.

Book Chapters:

Rowland, L.J. and F.A. Hammerschlag. Blueberry. 2003. *In*: R.E. Litz (ed.). Biotechnology of Fruit and Nut Crops, CABI Publishing, Wallingord. (In press)

Collaborators:

Xiaoling Cao, Shaanxi Fruit Crops Research Center, Xian, PRC, for collaborative studies on blueberry regeneration and transformation.

Sandra Garcés, Pontificia Universidad Católica del Ecuador, Quito, Ecuador, for collaborative studies on in vitro screening of strawberry for resistance to *Colletotrichum acutatum*.

Margery Koch-Dean, Volcani Center, Rehovoth, Israel, for collaborative studies on in vitro screening of strawberry for resistance to *Colletotrichum acutatum*.

Qingzhong Liu, Shandong Research Institute of Pomology, Taian, P.R. China, for collaborative studies on increasing fire blight resistance in apple via *Agrobacterium*-mediated gene transfer of the bacterial peptide gene cecropin.

Barbara Smith, USDA/ARS, Poplarsville, MS, for collaborative studies on in vitro screening of strawberry for resistance to *Colletotrichum acutatum*.

Nick Vorsa, Blueberry & Cranberry Research Center, Rutgers University, Chatsworth, NJ, for collaborative studies on blueberry transformation.

John S. Hartung

Research Plant Pathologist – Exotic Diseases of Citrus

Research: Research focuses on characterizing exotic pathogens of Citrus and maintaining and facilitating cooperative research on the Exotic Pathogens of Citrus Collection (EPCC). Current research projects include: establishing the etiology of novel diseases of citrus and characterizing the pathogens responsible for them; identifying the virulence mechanisms used by exotic pathogens with a combination of genetic and functional genomic techniques; and developing novel rapid, sensitive and quantitative diagnostic tests for the presence of exotic citrus pathogens in plant tissues. Future plans include: conducting further studies using confocal microscopy and GFP labeled strains of *X. fastidiosa* to study colonization of primary and secondary hosts of the bacterium; completing the development of a real-time PCR based detection method for *Liberobacter* spp., the causal agent for citrus greening disease; studying the interactions between *X. fastidiosa* and endophytic bacteria in planta; characterizing the populations of *X. fastidiosa* present in two significant regions, Costa Rica and Puerto Rico; and maintaining the collection of exotic pathogens of citrus with detailed inventories and moving the collection into a planned new greenhouse complex.

Publications (2000 to present):

Peer-Reviewed Journal Articles:

Da Costa, P.I., C.F. Franco, V.S. Miranda, D.C. Teixeira, and J.S. Hartung. 2000. Strains of Xylella fastidiosa rapidly distinguished by Arbitrarily Primed-PCR. Current Microbiol. 40:279-282.

He, C.X., W.B. Li, A.J. Ayres, J.S. Hartung, V.S. Miranda, and D.C. Teixeira. 2000. Distribution of *Xylella fastidiosa* in citrus rootstocks and transmission of citrus variegated chlorosis between sweet orange (*C. sinensis* (L.) Osbeck) plants through natural root grafts. Plant Dis. 84(6): 622-626.

Chen, J., R.L Jarret, X. Qin, J.S. Hartung, C.J. Chang, and D.L. Hopkins. 2000. 16SrDNA Analysis of *Xylella fastidiosa*. Syst.and Appl. Microbiol. 23:349-354. PEER

Qin, X., V.S. Miranda, M. Machado, E. Lemos, and J.S. Hartung. 2001. An evaluation of the Genetic Diversity of *Xylella fastidiosa* isolated from Diseased Citrus and Coffee. Phytopathology 91(6):599-605.

Li, W.B., W.D Pria, Jr., D.C. Teixera, V.S. Miranda, A.J. Ayres, C.F. Franco, M.G. Costa, C.X. He, P.I. Costa, and J.S. Hartung. 2001. Coffee Leaf Scorch caused by a strain of *Xylella fastidiosa* from citrus. Plant Dis. 85 (5):501-505.

Qin, X. and J.S. Hartung. 2001. Construction of a shuttle vector and transformation of *Xylella fastidiosa* with plasmid DNA. Current Microbiol. 43:158-162.

Huang, Q. and J.S. Hartung. 2001. Cloning and Sequence Analysis of a Citrus Yellow Mosaic Virus Genome Infectious to Sweet Orange via *Agrobacterium*-Mediated Inoculation. J. Gen. Virol. 82(10): 2549-2558.

Chagas, C.M., R.P. Jose, T. Namekata, J.S Hartung, and P.T. Yamamoto. 2001. *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae) and its relationship with the citrus canker bacterium *Xanthomonas axonopodis* pv citri in Brazil. Neotropical Entomol. 30(1):55-59.

Maas, J.L., C.C. Gouin, S.C. Hokanson, and J.S. Hartung. 2002. Strawberry parent clones US 4808 and US 4809 resistant to Bacterial Angular Leafspot Disease caused by *Xanthomonas fragariae*. HortScience: 37(4):716-717.

Li, W., C. Zhou, W.D. Pria, Jr., D.C. Teixera, V.S. Miranda, A.J. Pereira, C. –X. He, P.I. Costa, and J.S. Hartung. 2002. Citrus and coffee strains of *Xylella fastidiosa* induce Pierce's disease of grapevine. Plant Dis. 86:1206-1210.

Pria, Jr., W.D., P.M. Lacava, W.B. Li, V.S. Miranda, P.I. Costa, P.R.S. Farias, J.S. Hartung, E.O. Pereira, and F.J.B. Francischini. 2002. Efeito da *Xylella fastidosa* em frutos and sementes de laranja doce (*Citrus sinensis* [L.] Osbeck) afetados pela CVC. Laranja, Cordeiropolis 23(1):183-202.

Chen, J., J.S. Hartung, C.J. Chang, and A.K. Vidaver. 2002. An evolutionary perspective of Pierce's disease of grapevine, citrus variegated chlorosis, and mulberry leaf scorch diseases. Current Microbiol. 45(6):423-428.

Brlansky, R.H., V.D. Damsteegt, and J.S. Hartung. 2002. Transmission of the citrus variegated chlorosis bacterium, *Xylella fastidiosa*, with the Florida sharpshooter, *Oncometopia nigricans* Walker. Plant Dis. 86: 1237-1239.

Lewers, K.S., J.L. Maas, S.C. Hokanson, C.C. Gouin, and J.S. Hartung. 2003. Inheritance of resistance in strawberry to bacterial angular leafspot disease caused by *Xanthomonas fragariae*. J. Amer. Soc. Hort. Sci. 128 (2):209-212.

Li, W.B., W.D. Pria, Jr., P.M. Lacava, and J.S. Hartung. 2003. Presence of *Xylella fastidiosa* in Sweet Orange Fruit and Seeds and its Transmission to Seedlings. Phytopathology 93 (8):953-958.

Huang, Q. and J. S. Hartung. 2003. Association of *Xylella fastidiosa* with leaf scorch in Japanese beach bonsai. Can. J. Plant Pathol. 25:401-405.

Conference Proceedings:

Hartung, J.S., C.C. Gouin, K.S. Lewers, J.L. Maas, and S.C. Hokanson. 2003. Identification of sources of resistance to bacterial angular leafspot disease of strawberry. Acta Hort. 626:155-159.

Brlansky, R., D. Howd, J.S. Hartung, and Q. Huang. 2002. Ultrastructure of citrus infected with citrus yellow mosaic virus. pp 378-381 *In:* N. Duran-Vila, R.G. Milne, and J.V. da Graca (eds.), Proc. 15th Conf. Intl. Org. Citrus Virol., Intl. Org. Citrus Virol., Riverside, California.

Howd, D.S., J.S. Hartung, and R.H. Brlansky. 2002. Ultrastructure of Citrus Chlorotic Dwarf Virus infected leaves and bark. pp 373-377. *In:* N. Duran-Vila, R.G. Milne, and J.V. da Graca (eds.), Proc. 15th Conf. of the Intl. Org. Citrus Virol., Intl. Org. Citrus Virol., Riverside, California.

Brlansky, R.H., D.S. Howd, J.S. Hartung, S.A. Garnsey, and S. Korkmaz. 2002. Purification of virus-like particles from citrus chlorotic dwarf infected and healthy Citrus tissues. pp 440 *In:* N. Duran-Vila, R.G. Milne, and J.V. da Graca (eds.), Proc. 15th Conference of the Intl Org. Citrus Virol., Intl. Org. Citrus Virol., Riverside, California.

Book Chapters:

Hartung, J.S. 2002. Phytosanitary Quarantine as a Disease Control Measure. *In*: D. Pimental (ed.), Encyclopedia of Pest Management. Marcel-Dekker, Inc., New York. DOI: 10.1081/E-EPM 120009964.

Hartung, J.S. 2004. Pierce's disease and *Xylella fastidiosa*. *In*: R. M. Goodman (ed.), Encyclopedia of Crop and Soil Science. Marcel-Dekker, Inc. New York. DOI:10.1081/E-EPCS 120010583.

Collaborators:

Pete Anderson, University of Florida, Quincey, FL. Characterization of *Xylella fastidiosa* in Puerto Rico.

Joao Lucio Azevedo, University of Sao Paulo, ESALQ, Sao Paulo, Brazil. Interaction of *Xylella fastidiosa* with endophytic bacteria.

Ron Brlansky, University of Florida. Ultrastructure and transmission of exotic citrus pathogens by insects.

Jianchi Chen, USDA-ARS, San Joaquin Valley Agricultural Sciences Center, Parlier, California. Population structure and functional genomics of *Xylella fastidiosa.*

Vern Damsteegt, USDA-ARS, Foreign diseases and Weed Sciences Research Laboratory, Fort Detrick, MD. Transmission of exotic citrus pathogens by insects.

Mark Hilf, USDA ARS, US Horticultural Research Laboratory, Fort Pierce, FL. Molecular characterization of *citrus tristeza virus*.

Toru Iwanami, National Agricultural Research Center for Kyushu Okinawa Region, Kumamoto, Japan. Diagnosis and differentiation of strain of the citrus greening agent, Liberobacter spp.

Sirosh Korkmaz, University of Adana, Turkey. Purification and characterization of *citrus chlorotic dwarf virus.*

Richard Lee, USDA RS, Citrus and Date Germplasm Repository, Riverside, CA. Phytoplasmas of citrus and characterization of *citrus tristeza virus*.

Marielos Mora, University of Costa Rica, San Jose, Costa Rica. Characterization of *Xylella fastidiosa* in Costa Rica.

Carmen Rivera, University of Costa Rica, San Jose, Costa Rica. Characterization of *Xylella fastidiosa* in Costa Rica.

Suzanne S. Hurtt

Plant Pathologist - Plant Quarantine

Research: Program focuses on state and federal quarantine for international and domestic movement of *Saccharum* genetic resources and also federal quarantine for plant and genetic resources of potato and sweet potato. The current program includes: 1) overseeing the quarantine and indexing of *Solanum tuberosa* (potato), *Ipomoea batatas* (sweet potato) and *Saccharum officinarum* (sugarcane); 2) coordinating the acquisition activities, then establishing and maintaining propagation of imported germplasm for assigned crops; 3) preventing the introduction of economic and/or quarantine significance by detecting the presence of pathogens in germplasm; 4) releasing and distributing propagative materials of germplasm that are free of regulated pathogens; 5) developing and implementing improved methods to detect pathogens of concern; 6) investigating the etiology of new or unusual diseases of sweet potato, potato and sugarcane; and 7) with the PGQO tissue culture and molecular laboratories, developing tests that are applicable to *in vitro* germplasm and improving methods to eliminate pathogens from infected germplasm. Future plans include: 1) continuing to perform quarantine activities necessary to process germplasm of *Ipomoea, Solanum*, and *Saccharum spp.;* 2)continuing studies on the etiology of sweet potato viruslike diseases and characterization of the causal agents to improve the indexing methods used by PGQO; 3) expanding the use of molecular-based testing for pathogens; 4) developing new methods that can be used to screen *in vitro* plantlets for pathogens; and 5) in collaboration with the tissue culture program, developing and implementing therapeutic *in vitro* therapeutic treatments for the elimination of mosaic-inducing pathogens in sugarcane.

Publications (2000 - Present):

Conference Proceedings:

Lotrakul, P., R. Valverdi, C. Clark, S. Hurtt, and M. Hoy. 2002. Sweetpotato leaf curl virus and related geminiviruses in sweetpotato. Acta Hort. 583:135-141.

Pamphlet:

Clark,C., S. Fuentes, S. Hurtt, J. Moyer. L. Salazar, and R. Valverde. 2001. Some symptoms caused by virus and viruslike agents in *Ipomoea batatas* and related species, CIP Publishers.

Germplasm Releases:

Released 313 clones of potato, 163 true potato seed lots, 110 sweetpotatoes, 270 sugarcane introductions from foreign sources and 266 from domestic donors.

Collaborators:

Chris Clark, Louisiana State University, Dept. Plant Pathology and Physiology, Baton Rouge, LA., for detection and characterization of sweet potato viruses.

Jack Comstock, ARS, Sugarcane Field Station, Canal Point, FL, for new pathogens and detection methods for sugarcane viruses.

Crop Germplasm Committees: Acquisition of germplasm and ARS germplasm needs via plant exploration or exchanges; PGQO program and protocol reviews; assessments of annual progress.

Curators at the ARS germplasm repositories: Acquisition of germplasm and distribution of released germplasm. Special project with NRSP6 (Dr. John Bamberg) for increasing lots of true potato seeds with low seed numbers. Seeds are germinated and plants are crossed at the Sturgeon Bay, WI, repository, while leaf samples are tested at PGQO for viruses.

Foreign individuals (donors) who provide the desired germplasm: To obtain propagative materials in a timely fashion and in keeping with U.S. regulations. Provide mailing labels and instructions for shipping materials to U.S.

Michael Irey, U.S. Sugar Corp. Clewiston, FL, for detection of pathogens of sugarcane.

Zvezdana Pesic-Van Esbroeck, North Carolina State Univeristy, Raleigh, NC, for detection and characterization of viruses of sweet potato.

Regulatory Personnel at the Federal (APHIS) and state levels: To obtain and maintain permits for both germplasm and pests maintained by PGQO. The latter includes pathogens found in germplasm and culture of pathogens used for positive controls. To obtain authority to release and distribute germplasm. To obtain approval of protocols used for indexing for pathogens. To obtain and maintain pesticide applicators licenses.

U.S. individuals (recipients) in the federal, university, or private sector who desire foreign germplasm: Communicate to determine the source of the plant materials and how to obtain it. Communicate to advise clients of arrival, establishment, and testing results, then to distribute released germplasm.

Rodrigo Valverde, Louisiana State University, Dept. Plant Pathology and Physiology, Baton Rouge, LA, for detection and characterization of viruses of sweet potato.

Gary R. Kinard
Plant Pathologist - Plant Virology

Research: This program focuses on the importation, quarantine testing and release of vegetative pome (apple, pear, quince) germplasm. Current efforts include the detection of pathogens of quarantine significance using a combination of greenhouse and field biological indicator plants, as well as laboratory molecular and serological tests. A regular supply of high quality indicator trees from a commercial nursery and new procedures to ensure proper care of indicator trees in the orchard are facilitating improved flow of germplasm through the program. Quarantine pathogens, including apple proliferation phytoplasma (does not occur in the US), are being intercepted on imported germplasm. Infected accessions are being identified for transfer to the therapy program. Other current efforts in cooperation with PGQO staff are resulting in an improved Access based system for tracking accessions and generating the lists and labels for testing, releases, and distributions. With the testing program operating more efficiently, future plans include working with colleagues to adapt, develop, test, and incorporate improved diagnostic methods into the program. Efforts are already underway to adapt molecular tests for apple dimple fruit and apple fruit crinkle viroids into the testing protocols. Other opportunities for advancement include incorporating molecular tests for the common latent viruses into the program.

Publications (2000 - Present):

Conference Proceedings:

Kinard, G.R., H.E. Waterworth, and R.G. Mock. 2001. Advances in quarantine testing of temperate fruit tree germplasm at USDA. Acta Hort. 550:441-445.

Kinard, G.R. and R. Jordan. 2002. Genome organization of pelargonium chlorotic ring pattern virus: further implications for tombusviridae taxonomy. Acta Hort. 586:17-27, 2002.

Jordan, R., M.A. Guaragna, G.R. Kinard, and S. Lynn. 2002. Detection and first report of dasheen mosaic virus and a second potyvirus infecting the terrestrial orchid Spiranthes cernua. Acta Hort. 586:253-260.

Germplasm Releases (2000-2003):

105 apple accessions unconditionally released
89 apple accessions provisionally released
11 pear accessions unconditionally released
139 pear accessions provisionally released
25 quince accessions provisionally released

Collaborators:

USDA-APHIS and US state regulatory officials to coordinate importation, testing, release, and distribution of vegetative pome germplasm.

Curators at USDA apple (Geneva, NY) and pear (Corvallis, OR) repositories to request foreign germplasm accessions and coordinate final or provisional release of tested germplasm.

Apple and pear crop germplasm committee chairs to provide annual progress reports and establish priorities for foreign germplasm acquisitions.

Canadian Quarantine Officials to share information on new or improved detection methods and incidence of pathogens of quarantine significance.

NRSP5 staff (Prosser, WA) to share information on new or improved detection methods and incidence of pathogens of quarantine significance. NRSP5 is the only other program in the US that processes prohibited foreign pome germplasm through quarantine.

US clients (scientists, nurserymen, collectors) to coordinate requests to import foreign germplasm, communicate status of material in testing, and arrange for provisional or final release of germplasm.

Steven A. King
Information Technology Specialist

Research: Program focuses on processing foreign plant germplasm through quarantine. Currently the emphasis is on: developing a new Quarantine Information System (QIS) for tracking incoming material, testing progress, and shipment of released material; developing a new Quarantine Information System (QIS) for tracking incoming material, testing progress, and shipment of released material; synchronizing accession and order data between QIS and the Germplasm Resources Information Network (GRIN); upgrading and maintain Local Area Networks (LAN) server hardware, wiring schema, and network distribution equipment for both the PGQO and Fruit Laboratory; and developing a core of current and supportable applications to provide word processing, database, e-Mail, and Internet browsing capabilities to all workstations within the PGQO and Fruit Laboratory. Migrate to an entirely Windows XP pro based workstation environment. Future efforts will focus on: developing a core of current and supportable applications to provide word processing, database, e-Mail, and Internet browsing capabilities to all workstations within the PGQO and Fruit Laboratory; migrating to an entirely Windows XP pro based workstation environment; converting all existing Windows 2000 pro based workstations to Windows XP pro systems.; continuing the workstation replacement program in order to phase out remaining Windows 98 based systems in favor of Windows XP pro based systems; utilizing the available licensing of Novell Netware 6.5 to upgrade the file server and user licensing; continuing the creation of various information entry and installing new versions of the applications core, specifically MS Office XP; and providing training and support for new applications to the end users.

Collaborators:

Mark Bohning, USDA-ARS, PSI, DBMU, Beltsville, MD for collaborative aid in interpretation of GRIN database inter-relation, and data structure.

Gorm Emberland USDA-ARS, PSI, DBMU, Beltsville, MD for collaborative information into the original structure of QIS, and aid in creation of loader databases for GRIN.

Kurt Endress and John Belt, USDA-ARS, PSI, DBMU, Beltsville, MD for collaborative support of the network infrastructure.

Glenn Jones USDA-ARS, PSI, I/T Division, Beltsville, MD for collaborative support of the telecommunications services at Buildings 010A and 580.

Tasha Sprague USDA-ARS, PSI, Beltsville, MD for collaborative support of I/T needs at Buildings 010A and 580.

Kimberly S. Lewers
Research Geneticist - Small Fruits

Research: The goal of this project is to develop strawberry and bramble germplasm, combining resistance to the prevalent diseases and the highest degree of fruit production and quality possible, using both classical and molecular techniques. The project will identify and evaluate disease resistant germplasm, and develop improved methods, including the use of marker-assisted breeding, to incorporate the resistance into superior germplasm. Because molecular markers for strawberry and bramble are few and have not been routinely used, our goals also are to develop and test Simple Sequence Repeat (SSR) molecular markers for strawberry and brambles, genetically map SSR markers and plant or fruit traits of economic importance, and use them in marker-assisted breeding. Future plans include the continuation of the well-established program for June-bearing strawberry cultivar development and germplasm enhancement with emphasis on resistance to *Colletotrichum* and *Botrytis*; the development of heat-tolerant everbearing strawberry cultivars; the development of thornless blackberry cultivars for the Eastern U.S.; the development of SSR markers for strawberry and bramble; the identification of SSR markers associated with strawberry resistance to bacterial angular leafspot disease, blackberry SSR markers associated with primocane fruiting and thornlessness , raspberry SSRs associated with fruit color, tipping, and fall fruiting; and the utilization of SSRs in germplasm characterization, identification, evolutionary comparisons, and marker-assisted breeding.

Publications (2000 – Present):

Peer Reviewed Journal Articles:

Ashley, M.V., S.M.N. Styan, K.J. Craft, K.L. Jones, K.A. Feldheim, J.L. Fessler, K.S. Lewers, and T. -L. Ashman. 2003. High Variability and Disomic Segregation of Microsatellites in the Octoploid *Fragaria virginiana* Mill. (Rosaceae). Theor. and Appl. Genet. 107:1201-1207.

Lewers, K.S., J.L. Maas, S.C. Hokanson, T.C. Gouin, and J.S. Hartung. 2003. Inheritance of Resistance in Strawberry to Bacterial Angular Leafspot Disease Caused by *Xanthomonas fragariae*. The J. Amer. Soc. of Hort. Sci. 128:209-212.

Lewers, K., Heinz, R., H. Beard, L. Marek, and B. Matthews. 2002. A physical map of a gene-dense region in soybean Linkage Group A2 near the black seed coat and Rhg_4 loci. Theor. and Appl. Genet. 104:254-260.

Mahama, A.A., K.S. Lewers, and R.G. Palmer. 2002. Genetic Linkage in Soybean: Classical Genetic Linkage Groups 6 and 8. Crop Sci. 2002 42: 1459-1464.

Lewers, K., S.D. Nilmalgoda, A.L. Warner, H.T. Knapp, B.F. Matthews. 2001. Physical mapping of resistant and susceptible soybean genomes near the soybean cyst nematode resistance gene *Rhg_4*. Genome 44:1057-1064.

Vaghchhipawala, Z., R. Bassüner, K. Clayton, K. Lewers, R. Shoemaker, and S. Mackenzie. 2001. Modulations in gene expression and mapping of genes associated with cyst nematode infection of soybean. Mol. Plant-Microbe Interactions: 14:42-54.

Matthews, B.F., T.E. Devine, J. Weisemann, H.S. Beard, K.S. Lewers, M.H. MacDonald, Y.B. Park, R. Maiti, J.J. Lin, J.Kuo, M.J. Pedroni, P.B. Cregan, and J.A. Saunders. 2001. Incorporation of sequenced cDNA and genomic markers into the soybean genetic map. Crop Sci. 41:516-521.

Technology Transfer, Patents, Releases:

K.S. Lewers, J.M. Enns, J.L. Maas, G.J. Galletta, and S.C. Hokanson. 9 January 2003. Notice to Nurseries and Propagators of the Naming and Release of 'Ovation' June-bearing Strawberry Cultivar.

Collaborators:

M.V. Ashley, University of Illinoios at Chicago; T.-L. Ashman, University of Pittsburgh; N.V. Bassil, USDA-ARS Corvallis, OR; T.M. Davis, University of New Hampshire for SSR development and testing.

J. Ballington, North Carolina State Univversity; J.R. Clark, University of Arkansas; K. Demchack, Pennsyvania State University; R.C. Funt, Ohio State University; S.A. Garrison, Rutgers; S.C. Hokanson, University of Minnesota; G.L. Jelenkovic, Rutgers; J.J. Luby, Universit of Minnesota; G.R. Nonnecke, Iowa State University; P.R. Probasco, Rutgers; B.J. Smith, USDA-ARS Poplarville, MS; B.R. Smith, University of Wisconsin; C.A. Weber, Cornell University for Cultivar development.

J.R. Clark, University of Arkansas; J. Graham, Scottish Crops Research Institute, Dundee; E. Staphne, University of Arkansas; C.A. Weber, Cornell University for Bramble mapping.

J.F. Hancock, Michigan State University; S.C. Hokanson, University of Minnesota; S. Serçe, University of Minnesota; B.J. Smith, USDA-ARS Poplarville, MS. Germplasm evaluation for anthracnose resistance.

J.J. Luby, University of Minnesota for BALD resistance and mapping.

R.R.Martin, USDA-ARS Corvallis, OR. Development of pallidosis RT-PCR assay.

Ruhui Li
Plant Pathologist - Plant Quarantine

Research: Research focuses on federal quarantine for the importation of plant genetic resources and federal quarantine for international and domestic movement of *Saccharum* (Sugarcane) genetic resources with an emphasis on molecular diagnostic program development. Current research focuses on studies to: 1) develop molecular techniques for detection of viruses and subviral pathogens of quarantine crops; 2) develop or adapt rapid, sensitive and reliable nucleic acid-based diagnostic methods for detection of important exotic pathogens of quarantine crops; and 3) characterize novel pathogens for development of rapid and reliable techniques for their diagnosis and detection. The future work of the program will focus on: 1) applying approved molecular techniques for detection of pathogens in quarantine crops; 2) integrating the RT-PCR assays for detection of foveaviruses, BRV, ScYLV, and other viruses into indexing program; 3) developing or adapting molecular techniques for detection of new viroids and viruses in quarantine crops; and 4) defining the unknown ryegrass virus.

Publications (2000 – present):

Peer-Reviewed Journal Articles:

Murphy, J.F., M.S. Reddy, C.-M. Ryu, J.W. Kloepper, and R. Li. 2003 Rhizobacteria-Mediated Growth Promotion of Tomato Leads to Protection Against *Cucumber mosaic virus*. Phytopathology 93(10): 301-1307.

Bowen, K.L., J.F. Murphy, K.L. Flanders, and R. Li. 2003. Incidence of viruses infecting winter wheat in Alabama. Plant Dis. 87 (3): 288-293.

Collaborators:

Jack Comstock, ARS, Sugarcane Field Station, Canal Point, FL. Detection methods for sugarcane viruses.

Michael Grisham, ARS, Sugarcane Research Unit, Houma, LA. Detection methods for sugarcane viruses.

Zongrang Liu, Appalachian Fruit Research Station, Kearneysville, WA. Engineering the prunus resistant to multiple virus pathogens.

Clarrisa Maroon and John Hammond, Floral and Nursery Plants Research Unit, Beltsville, MD. Characterization of an unknown virus infecting ryegrass.

Rodrigo Valverde, Louisiana State University, Dept. Plant Pathology and Physiology, Baton Rouge, LA. Detection of geminiviruses of sweet potato.

Raymond G. Mock

Plant Pathologist - Plant Quarantine

Research: The program focuses on providing a timely import, quarantine, and release of pathogen-tested germplasm obtained from foreign sources. Crops covered under this program include stone fruits, small fruits, forage and turf grasses, and miscellaneous tropical crops and woody ornamentals. Capacities are adhered to so that all programs of the PGQO can effectively operate within the confines of the building 580 quarantine facility. After following strict testing protocols, comprised of mechanical and graft transmissions, serological and molecular detection tests, and electron microscopy, germplasm accessions are formally released and shipped to recipients in the U.S. breeding community (federal, state, and private companies and individuals). The testing protocols, outlined by USDA-APHIS, are subject to change as more rapid and efficient testing techniques to incorporate are found. Current research focuses on developing a more effective method for the detection of Foveaviruses in Prunus sp. accessions. Upon completion, data will be presented to USDA-APHIS, to modify the testing protocol and provide an increase in reliability and a savings of time and money to the PGQO quarantine program. Research is also currently underway to identify and characterize an unknown viral pathogen intercepted in imports of *Lolium perenne.* Plans for the future of the quarantine program are partially dependent on acquiring the new facility space in building 580. The added space will provide a better environment for growth of our imported accession and test plants, allowing increased efficiency of our testing program and production of a better quality product of released germplasm to ship to our customers, the U. S. breeding community. The quarantine program will continue to improve as we identify and examine new detection methods through collaborative research to adapt our testing protocols.

Publications (2000 - Present):

Conference Proceeding:

Kinard, G.R., H.E. Waterworth, and R.G. Mock. 2001. Advances in quarantine testing of temperate fruit tree Germplasm at USDA. Proc. 18th Int. Symp. on Fruit Tree Virus Diseases, Acta Hort. 550: 441 - 445.

Mock, R.G. 2003. USDA Plant Quarantine: The First Line of Defense Against Invading Plant Pathogens. Pomona. (In press)

Germplasm Releases:

In the past five years, released (unconditional, provisional, and conditional) accessions of prohibited plant germplasm as follows: Stone Fruit - 963; Small Fruit - 32; Forage and Turf Grass - 161; Corn - 5; and Woody Ornamentals - 4.

Collaborators:

Canadian Quarantine Officials in Saanichton, B.C., CA: With Dan Thompson to gather information on new or improved detection methods for stone fruit and Ribes germplasm quarantine. With Ray Johnson to observe improved methods for quarantine testing of Rubus germplasm.

Crop Germplasm Committees to keep crop working groups informed of quarantine activities by annual quarantine reports, and to seek aid in prioritizing foreign germplasm acquisitions. Stone Fruit, Small Fruit, and Forage and Turf Grasses.

Curators at USDA National Germplasm Repositories to arrange for the acquisition of important genetic resources and to transfer pathogen-free tested germplasm to respective repositories to be incorporated into the U.S. agriculture gene pool. Stone fruit - Davis, CA and Geneva, NY; Small fruit - Corvallis, OR; Forage and Turf grass - S9, Griffin, GA, W-6, Pullman, WA, and NC-7, Ames, IA.

Ing-Ming Lee, USDA, ARS, MPPL, Beltsville, MD for collaborative work on phytoplasma's infecting stone fruit germplasm.

NRSP5 staff in Prosser, WA: With Bill Howell to share information on new or improved detection methods and incidence of pathogens of quarantine significance. With Jim Crosslin to acquire a probe for the Hop Stunt Viroid for use in the PGQO stone fruit testing protocol.

Ralph Scorza, USDA, ARS, AFRS, Kearneysville, WV for collaborative work to identify Prunus cultivars with varying degrees of sensitivity to Prunus pathogens.

USDA, APHIS: With Joseph Foster, NPGBL, Beltsville, MD to re-organize the stone fruit testing protocol, providing increased efficiency in testing procedures. With the Permits Division, Riverdale, MD to obtain and maintain plant and pest permits for use in PGQO; and to advise in their approval procedures in the granting of individual permit requests for research throughout the U.S. With Laurene Levy, NPGBL, Beltsville, MD in improving detection procedures for stone fruit pathogens.

U.S. Germplasm Importers (Federal, State, and individual scientists/breeders) to coordinate requests to import foreign germplasm, communicate status of material in testing, and arrange for distribution of released germplasm.

James J. Polashock

Research Plant Pathologist - Small Fruits

Research: Research focuses on enhancement of small fruit germplasm through breeding and molecular approaches with emphasis on disease resistance. Current research includes studies to: identify sources of resistance to fungal diseases, including anthracnose fruit-rot (*Colletotrichum acutatum*), mummy berry (*Monilinia vaccinii-corymbosi*), stem blight (*Botryosphaeria dothidea*), and Phomopsis twig blight (*Phomopsis vaccinii*); develop improved screening procedures to select for resistance to diseases, with emphasis on ultimately developing marker-assisted selection for seedling screening; determine the molecular plant microbe interactions for particular fungal and viral diseases that can be utilized in developing alternative disease control approaches; and develop methodology for tissue culture regeneration and high frequency transformation of blueberry. Future research includes studies to identify and assemble blueberry families to be used for disease resistance work and marker-assisted selection; utilize EST and AFLP markers for determining the mode of inheritance in interspecific blueberry hybrids; investigate the correlation of anthracnose fruit-rot resistance with fruit volatiles; and explore pollen transformation as a method of generating transgenic blueberry and cranberry.

Publications (2000 - Present):

Peer-Reviewed Journal Articles:

Qu, L., J. Polashock and N. Vorsa. 2000. A highly efficient *in vitro* cranberry regeneration system using leaf explants. HortScience 35:948-952.

Stretch, A., M. Ehlenfeldt, V. Brewster, N. Vorsa, and J. Polashock. 2001. Resistance of diploid *Vaccinium* spp. to the fruit rot stage of mummy berry disease. Plant Dis. 85:27-30.

Polashock, J. and N. Vorsa. 2002. Development of SCARs for DNA fingerprinting and germplasm analysis of cranberry. J. Amer. Soc. Hort. Sci. 127(4):677-684.

Polashock, J., R. Griesbach, and N. Vorsa. 2002. Isolation and characterization of the dihydroflavonol-4-reductase encoding gene from cranberry (*Vaccinium macrocarpon*). Plant Sci. 163:241-251.

Glasheen, B., J. Polashock, D. Lawrence, J. Gillet, D. Ramsdell, N. Vorsa, and B. Hillman. 2002. Cloning, sequencing, and promoter identification of *Blueberry red ringspot virus*, a member of the family *Caulimoviridae* with similarities to the 'Soybean chlorotic mottle-like genus'. Archives of Virol. 147(11):2169-2186.

Vorsa, N., J. Polashock, D. Cunningham, and R. Roderick. 2003. Genetic inferences from analysis of cranberry germplasm anthocyanin profiles and breeding implications. J. Amer. Soc. Hort. Sci.128(5):691-697.

Rowland, L.J., A.L. Dhanaraj, J.J. Polashock, and R. Arora. 2004. Utility of blueberry-derived EST-PCR primers in related Ericaceae species. HortScience. (In press)

Conference Proceedings:

Polashock, J. and N. Vorsa. 2003. Breeding and biotechnology: A combined approach to cranberry improvement. IN: Proc Seventh Int Symp Vaccinium Culture. Termas de Chillan, Chile, 4- 9. Acta Hort.

Collaborators

Dr. Chee-Kok Chin, Rutgers University, New Brunswick, NJ for determining if fruit volatiles affect resistance to certain fungal diseases.

Dr. Bradley Hillman, Rutgers University, New Brunswick, NJ to develop methods of virus resistance in blueberry.

Dr. Peter Oudemans, Rutgers University, New Brunswick, NJ to identify and characterize various pathogens of blueberry and cranberry.

Dr. Nicholi Vorsa, Rutgers University, New Brunswick, NJ for collaborative studies on cranberry anthocyanin glycosylation and impact on health benefits.

Lisa J. Rowland

Research Geneticist - Molecular Biology

Research: Research program focuses on identifying genes/molecular markers of horticultural significance in blueberry and making them available for marker-assisted breeding and transformation. Current projects use molecular approaches to better understand chilling requirement and cold tolerance in blueberry and include: further saturating genetic linkage maps of blueberry using EST-PCR markers; evaluating remainder of the mapping populations for chilling requirement and cold hardiness; isolating and characterizing the dehydrin gene family of blueberry; generating expressed sequence tags (ESTs) from cold acclimated and non-acclimated floral bud libraries; using EST-PCR markers for DNA fingerprinting of various blueberry genotypes and determining the mode of inheritance in a V. darrowi x V. corymbosum hybrid; and comparing the rate of deacclimation in several different blueberry genotypes with varying germplasm compositions and mid-winter bud hardiness levels. Future studies will be conducted to: map QTLs controlling chilling requirement and cold hardiness; generate more ESTs and imprint cDNAs onto microarrays to identify genes that are upregulated or downregulated during cold acclimation; map members of the dehydrin gene family and other cold acclimation-responsive genes from blueberry and determine whether any of the genes map to QTLs identified as controlling chilling requirement or cold hardiness; isolate genomic clones of the dehydrin gene family and characterize their promoters; make full-length clones of cold acclimation-responsive genes available for transformation to test their effects on cold hardiness; and determine if RAPD markers can distinguish tissue culture-induced variants of strawberry.

Publications (2000-present):

Peer-Reviewed Journal Articles:

Arora, R., L.J. Rowland, J.S. Lehman, C-C. Lim, G.R. Panta, and N. Vorsa. 2000. Genetic analysis of freezing tolerance in blueberry (*Vaccinium* section *Cyanococcus*). Theor. Appl. Genet. 100:690-696.

Degani, C., L.J. Rowland, J.A. Saunders, S.C. Hokanson, E.L. Ogden, A. Golan-Goldhirsh, and G.J. Galletta. 2001. A comparison of genetic relationship measures in strawberry (*Fragaria* x *ananassa* Duch.) based on AFLPs, RAPDs, and pedigree data. Euphytica 117:1-12.

Panta, G.R., M.W. Rieger, and L.J. Rowland. 2001. Effect of cold and drought stress on blueberry dehydrin accumulation. J. Hort. Sci. & Biotech. 76:549-556.

Parmentier-Line, C.M., G.R. Panta, and L.J. Rowland. 2002. Changes in dehydrin expression associated with cold, ABA and PEG treatments in blueberry cell cultures. Plant Sci.162:273-282.

Rowland, L.J., S. Mehra, A.L. Dhanaraj, E.L. Ogden, J.P. Slovin, and M.K. Ehlenfeldt. 2003. Development of EST-PCR markers for DNA fingerprinting and genetic relationship studies in blueberry (*Vaccinium*, section *Cyanococcus*). J. Amer. Soc. Hort. Sci. 128:682-690.

Rowland, L.J., A.L. Dhanaraj, J.J. Polashock, and R. Arora. 2004. Utility of blueberry derived EST-PCR primers in related *Ericaceae* species. HortScience. (In press)

Dhanaraj, A.L., J.P. Slovin, and L.J. Rowland. 2004. Analysis of gene expression associated with cold acclimation in blueberry floral buds using expressed sequence tags. Plant Science. (In press)

Golan-Goldhirsh, A. SZ.X. Wang, D.K. Khadka, L.J. Rowland, and V. Kostiukovsky. 2004. Genetic relationships among mediterannean *Pistacia* species evaluated by RAPD and AFLP markers. J. Systematics and Evolution. (In press)

Arora, R., L.J. Rowland, E.L. Ogden, A.L. Dhanaraj, C.O. Marian, M. K. Ehlenfeldt, and B.T. Vinyard. 2004. Dehardening, kinetics, bud development, and dehydrin metabolism in blueberry
(*Vaccinium* spp.) cultivars during deacclimation at constant warm temperatures. J. Amer. Soc. Hort. Sci. (In press)

Conference Proceedings:

Golan-Goldhirsh, A., R. Jones, and L.J. Rowland. 2001. AFLP markers for sex determination in an *Ilex* species. Acta Hort. 546:591-596.

Rowland, L.J., S. Mehra, A. Dhanaraj, E.L. Ogden, and R. Arora. 2003. Identification of molecular markers associated with cold tolerance in blueberry. Acta Hort. 625:59-69.

Ehlenfeldt, M.K., L.J. Rowland, and R. Arora. 2003. Bud hardiness and deacclimation in blueberry cultivars with varying species ancestry: flowering time may not be a good indicator of deacclimation. Acta Hort. 626:39-44.

Invited Papers and Review Articles:

Arora, R., L.J. Rowland, and K. Tanino. 2003. Induction and release of bud dormancy in woody perennials: a science comes of age. HortScience 38:911-921.

Panta, G.R., L.J. Rowland, R. Arora, E.L. Ogden, and C-C. Lim. Inheritance of cold hardiness and dehydrin genes in diploid mapping populations of blueberry. J. Crop Production. (In press)

Rowland, L.J., G.R. Panta, S. Mehra, and C. Parmentier-Line. 2004. Molecular genetic and physiological analysis of the cold-responsive dehydrins of blueberry. J. Crop Production. (In press)

Rowland, L.J. and F.A. Hammerschlag. Blueberry. In Litz, R.E. (ed.). Biotechnology of Fruit and Nut Crops. CABI Publishing. (In press)

Collaborators:

Rajeev Arora, Iowa State University, Dept. of Horticulture, Ames, IA, for collaborative studies on genetic control of cold hardiness in blueberry and rhododendron, testing blueberry-derived EST-PCR primers in rhododendron, and comparing rates of deacclimation and mid-winter cold hardiness levels in various blueberry genotypes.

Nahla Bassil and Peter Boches, USDA-ARS, National Clonal Germplasm Repository, Corvallis, OR, for collaborative studies on development of EST-derived SSR markers in blueberry.

Chemda Degani, The Volcani Center, Agricultural Research Organization, Institute of Horticulture, Bet-Dagan, Israel for collaborative studies on use of RAPD and AFLP markers to fingerprint and examine genetic relatedness of strawberry cultivars.

Avi Golan, Ben-Gurion University of the Negev, Desert Plant Biotechnology Laboratory, Sede Boker Campus, Israel for collaborative studies on use of RAPD and AFLP markers to fingerprint and examine genetic relatedness of strawberry cultivars and pistacio lines, use of AFLP markers to identify markers associated with sex determination in holly, and characterization of dehydrins in woody perennials.

Jeffrey Lehman, Otterbein College, Dept. of Life and Earth Sciences, Westerville, OH, for collaborative studies on genetic control of chilling requirement and cold hardiness in blueberry.

Hong Ma, Jim Leebens-Mack, and Claude de Pamphilis, Penn State University, The Huck Institute for Life Sciences, Dept. of Biology, University Park, PA, for collaborative studies on the "Floral Genome Project" involving generating ESTs from a cDNA library from floral buds of blueberry.

Mark Rieger, University of Georgia, Dept. of Horticulture, Athens, GA for collaborative studies on drought and cold stress in blueberry.

Nicholi Vorsa, Rutgers University, Blueberry and Cranberry Research Center, Chatsworth, NJ, for collaborative studies on genetic control of cold hardiness in blueberry.

Janet P. Slovin
Plant Molecular Biologist - Small Fruits

Research: Research focuses on the role(s) of heat shock proteins in the responses of small fruit crops to elevated temperature. Current studies include: 1) determining if specific proteins expressed by small fruit crops in response to heat stress function as part of the thermotolerance system, and if so, evaluating the potential for utilizing these proteins to improve crop stress responses; 2) determining the mechanisms by which heat shock proteins (Hsps) or other gene products affect thermotolerance using standard molecular and biochemical assays for chaperone function, intracellular localization, and protein-protein interaction; 3) evaluating the ability of a heterologous low molecular weight Hsp (*dcHsp17.7*) to influence thermotolerance in strawberry; and 4) developing better tools for investigating the role of Hsps or other gene products in strawberry thermotolerance. These tools include the development of an inbred diploid testing system as well as the development of assays for thermotolerance that have physiological and/or agricultural relevance. Future research will be directed to: 1) determining expression patterns for available strawberry thermo-stress response genes, 2) developing necessary antibodies for assessing protein expression of these genes; 3) developing assays for assessing the effects of elevated temperature on pollen, ovules, and runners as well as on cotyledon greening; 4) determining the influence of elevated temperature on expression of genes involved in flower and fruit production in strawberry; 5) obtaining additional EST sequence data with which to construct a small microarray for assaying the stress state of experimental plants, and with which to develop markers for a collaborative mapping project; and 6) determining the mode of action of *dcHsp17.7* using *Arabidopsis* and strawberry. We had previously demonstrated that this small Hsp dramatically influences thermotolerance in both carrot and tomato.

Publications (2000-present):

Peer-Reviewed Journal Articles:

Martin, M.N. and J.P. Slovin. 2000. Purified gamma-glutamyl transpeptidases from tomato exhibit high affinity for glutathione and glutathione S-conjugates. Plant Physiol. 122:1417-1426.

Rapparini F., Y.-Y. Tam, J.D. Cohen, J.P. Slovin. 2002. Indole-3-acetic acid metabolism in *Lemna gibba* undergoes dynamic changes in response to growth temperature. Plant Physiol 128:1410-1416.

Epstein, E., J.D. Cohen, J.P. Slovin. 2002. The biosynthetic pathway for indole-3-acetic acid changes during tomato fruit development. Plant Growth Regulation 38:15-20.

Walz A., S. Park, J.P. Slovin, J. Ludwig-Müller, Y. Momonoki, and J.D. Cohen. 2002. A gene encoding a protein modified by the phytohormone indoleacetic acid. Proc. Natl. Acad. Sci. USA 99:1718-1723.

Rowland, L.J., S. Mehra, A.L. Dhanaraj, E.L. Ogden, J.P. Slovin, and M.K. Ehlenfeldt. 2003. Development of EST-PCR markers for DNA fingerprinting and mapping in blueberry (*Vaccinium*, section Cyanococcus). J. Amer. Soc. Hort. Sci.128:682-690.

Lee, A.-K, J.-K. Suh, M. Roh, and J.P. Slovin. 2003. Analysis of genetic relationships of *Ardisia* spp. using RAPD markers. J. Hort. Sci. Biotechnol. 78(1):24-28.

Dhanaraj, A.L., J.P. Slovin, and L.J. Rowland. 2003. Analysis of gene expression associate with cold acclimation in blueberry floral buds using expressed sequence tags. Plant Sci. (In press)

Collaborators:

Jerry D. Cohen, University of Minnesota, Dept. Hort., for collaborative work investigating the role of IAA conjugated proteins in strawberry fruit development.

Dr. Aekyung Lee, Laboratory of Floriculture and Plant Physiology, School of Bio-Resources Science, Dankook University, Cheonan, Korea, for collaborative work on molecular markers and stress response proteins in seeds.

Jutta Ludwig-Mueller, Institut für Botanik, Technische Universität Dresden, Dresden, Germany for collaborative studies on IBA and IAA conjugated proteins.

Francesca Rapparini, Istituto di Ecofisiologia delle Piante Arboree da Frutto, Consiglio Nazionale delle Ricerche, Bologna, Italy for collaborative work on the effects of environment on metabolism of the plant hormone auxin.

Mark Roh, USDA-ARS, FNRU, US National Arboretum, Beltsville, MD for collaborative work on molecular markers and stress response proteins in seeds.

Rick Walden, Plant Breeding and Biotechnology, East Malling, UK for collaborative work to sequence cDNA clones from *Fragaria vesca* and continuing work to further develop this model system.

J. Lynn Zimmerman, University of MD, Baltimore County, Dept. Biological Sciences, for collaboration on the mode of action of dcHSP17.7.

Shiow Y. Wang
Plant Physiologist - Small Fruits

Research: Research focuses on: 1) enhancement of small fruit germplasm through genomic characterization and genetic improvement with emphasis on disease resistance, and 2) physiology of small fruit crops in sustainable production systems. Current research involves studies to: evaluate berry crops for nutritional value, with special focus on antioxidant capacity; and determine and modify the physiological, environmental, nutritional, and pathological factors influencing nutritional content of small fruit crops (blueberry, strawberry, and others) in sustainable production systems. Future research focuses on studies to: 1) evaluate the wild strawberry germplasm collection, the strawberry breeding program, the blackberry breeding program and the blueberry germplasm collection and lingonberry fruit for fruit quality and antioxident capacity; 2) study the possible anticancer and antioxidant properties of berry fruits; 3) evaluate effect of CO_2 enhancement on fruit quality and aroma compounds in strawberry; 4) conduct analyses of antioxidants in Autumn Berry fruit samples from different genotypes; and 5) evaluate the effect of preharvest and postharvest conditions on fruit quality and phytonutrient content in berry crops.

Publications (2000 - present):

Peer-Reviewed Journal Articles:

Wang, S.Y. and M.J. Camp. 2000. Temperature after bloom affects plant growth and fruit quality of strawberry. Sci. Hort. 85(3): 183-199.

Wang, S.Y. and H.S. Lin. 2000. Antioxidant activity in fruits and leaves of blackberry, raspberry, and strawberry varies with cultivar and developmental stage. J. Agri. Food Chem. 48: 140-146.

Wang, S.Y. and H.J. Jiao. 2000. Scavenging capacity of berry crops on superoxide radicals, hydrogen peroxide, hydroxyl radicals, and singlet oxygen. J. Agr. Food Chem. 48:5677-5684.

Jiao, H.J. and S.Y. Wang. 2000. Correlation of antioxidant capacities to oxygen radical scavenging enzyme activities in blackberry. J. Agr. Food Chem. 48:5672-5676.

Wang, S.Y. and A.W. Stretch. 2001. Antioxidant capacity in cranberry is influenced by cultivar and storage temperature. J. Agr. Food Chem. 49:969-974.

Wang, S.Y. and H.J. Jiao. 2001. Changes in oxygen-scavenging systems and membrane lipid peroxidation during maturation and ripening in blackberry. J. Agr. Food Chem. 49:1612-1619.

Kasperbauer, M.J., J.H. Loughrin, and S.Y. Wang. 2001. Light reflected from red mulch to ripening strawberries affects aroma, sugar and organic acid concentrations. Photochem. Photobiol. 74:103-107.

Wang, S.Y. and W. Zheng. 2001. Effect of plant growth temperature on antioxidant capacity in strawberry. J. Agr. Food Chem. 49:4977-4982.

Zheng, W. and S.Y. Wang. 2001. Antioxidant activity and phenolic compounds in selected herbs. J. Agr. Food Chem. 49:5165-5170.

Wang, S.Y. and H.S. Lin. 2002. Composts as soil supplement enhanced plant growth and fruit quality of strawberry. J. Plant Nutrition 25: 2243-2259.

Wang, S.Y., W. Zheng, and G.J. Galletta. 2002. Cultural system affects fruit quality and antioxidant capacity in strawberry. J. Agr. Food Chem. 50: 6534-6542.

Wang, S.Y., J.A. Bunce, and J.L. Maas. 2003. Elevated carbon dioxide increases contents of antioxidant compounds in field-grown strawberries. J. Agi. Food Chem. 51: 4315-4320.

Zheng, W. and S.Y. Wang. 2003. Oxygen radical absorbing capacity of flavonoids and phenolic acids in blueberries, cranberries, chokeberries and lingonberries. J. Agr. Food Chem. 51: 502-509.

Wang, S.Y. and H.S. Lin. 2003. Compost as a soil supplement increases the level of antioxidant compounds and oxygen radical absorbing capacity in strawberries. J. Agr. Food Chem. 51: 6844-6850.

Zheng, Y., C.Y. Wang, S.Y. Wang, and W. Zheng. 2003. Effect of high oxygen atmospheres on blueberry phenolics, anthocyanins and antioxidant capacity. J. Agr. Food Chem. 51:7162-7169.

Conference Proceedings:

Wang, S.Y. 2000. Effect of methyl jasmonate on water stress in strawberry. Acta. Hort. 516:89-96.

Wang, S.Y. and H.S. Lin. 2000. Antioxidant capacity of fruits and vegetables. Proc. Intl. Symposium on Quality Evaluation of Hort. Crops. pp.21-29. Miaoli, Taiwan.

Wang, S.Y. 2001. Antioxidant capacity of fruits, vegetables and herbs. Proceedings Intl. Symposium on Quality Evaluation of Agricultural Product, processing and storage. Tianjin, China. pp. 768-781.

Wang, S.Y. 2003. Antioxidant capacity of berry crops and herbs. In *Plant Foods and Herbs*; C.T. Ho., J.K. Lin., Q.Y. Zheng., Eds. ACS Symposium Series No. 859. pp. 190-201. American Chemical Society, Washington, DC.

Wang, S.Y., W. Zheng, and J.L. Maas. 2003. High plant growth temperatures increase antioxidant capacities in strawberry fruit. Acta Hort. 626:57-63.

Wang, S.Y. 2003. Antioxidant capacity of berry crops, culinary herbs and medicinal herbs. Acta Hort. 620:461-473.

Wang, S.Y. and H.S. Lin. 2003. Cultural conditions affect phytonutrient content and antioxidant activity in berry fruit. Proceedings Intl. Symposium on Plant Health Management, Taiwan (in press).

Filgueiras, H., S.Y. Wang, and C.Y. Wang. 2003. Antioxidant capacity of 'Kent' and 'Tommy Atkins' mango fruit stored at chilling temperature. Proceedings of International Symposium on Tropical and Subtropical Fruits (in press).

Filgueiras, H., S.Y. Wang, D. Min., Y. Lu, and C. Moura. 2003. Antioxidant capacity of fruit from five new clones of Acerola (*Malpighia emarginata* DC). Proceedings ofInternational Symposium on Tropical and Subtropical Fruits (in press).

Collaborators:

J. Ballington, NCSU, Raleigh, North Carolina, for collaborative studies evaluating deerberry fruit quality and antioxidant capacity.

J. A. Bunce, USDA-ARS, PSI, ACS, Beltsville, MD, for collaborative studies evaluating the effect of CO_2 enhancement on fruit quality and aroma compounds in strawberry.

M. Ding, CDC, NIOSH, Morgantown, WV, for collaborative studies evaluating the possible chemoprevention and antioxidant properties of berry fruits.

J. Fernando Ayala-Zavala, Visiting Scientist, CIAD, Hermosillo, Mexico, for collaborative studies evaluating the effect of postharvest handling and storage on fruit quality, phytonutrient content and antioxidant activity of berry crops.

H. Filgueras, Visiting Scientist, Food Technology, Embrapa, Brazil, for collaborative studies evaluating fruit quality of new clones of Acerola (*Malpighia emarginata* DC) and other horticultural crops.

M. J. Kasperbauer, Coastal Plains Soil, Water and Plant Research Station, ARS, USDA, Florence, SC, for collaborative studies evaluating the effects of growth temperatures and cultural practices (different mulch types) on fruit quality, carbohydrates, and organic acids in strawberries.

H. S. Lin, TransWorld Institute of Technology and Agricultural Improvement Station, Taiwan, for collaborative studies evaluating the effects of compost as a soil supplement on strawberry plant growth and fruit quality.

Patricia Millner, USDA-ARS, ANRI, SASL, Beltsville, MD, for collaborative studies evaluating the effect of methyl bromide, compost, cover crops, and raised bed on strawberry fruit quality and antioxidant capacity.

R. Penhallegon, Oregon State University, Oregon, for collaborative studies evaluating lingonberry fruit quality and antioxidant capacity.

W. Zheng, Visiting Scientist, Zhejiang University, China, for collaborative studies evaluating the effect of cultural conditions on oxygen radical absorbing capacity of flavonoids and phenolic content in berry crops.

Y. Zheng, Visiting Scientist, Nanjing University, China, for collaborative studies evaluating the effect of high oxygen atmospheres on blueberry phenolics, anthocyanins and antioxidant capacity.

SUPPORT STAFF

ADDENDA

Support Staff, Post-Doctoral, and Visiting Scientists

Kristia Adams
Biological Science Laboratory Technician

Kristia works with Dr. James Polashock at the USDA/Rutgers University Blueberry Cranberry Research facility located in Chatsworth, NJ. She is involved in the development of protocols for an efficient blueberry regeneration and transformation system. She is also assisting in studies to identify molecular markers related to disease resistance in blueberries so that they may be used to screen blueberry progeny produced by the USDA breeding program. Other current responsibilities include isolating fungal pathogens from field material, maintaining fungal cultures, maintaining greenhouse plants, and nucleic acid isolations from plant and fungal material. In 1994, she received a B.S. degree in Environmental Science from Stockton College of New Jersey. Kristia has been with the Fruit Lab since December 2002.

Gregory Anderson
Biological Science Aid

Greg has worked with Gareth Davis in the Plant Germplasm Quarantine Office since 2003, assisting in all aspects of the Tissue Culture lab's operations. He attends the University of Maryland, College Park, and is working towards a B.S. degree in Chemistry, with an anticipated completion in 2005.

Mchezaji Axum
Biological Science Laboratory Technician

Mchezaji works with Drs. Brent Black and Kim Lewers on small fruit diseases research. His duties include greenhouse and field plant maintenance, experiment design and setup and data acquisition. In 1997, he received a B.S. degree in agronomy from the University of Maryland. Mchezaji's interests largely are centered around sustainable agriculture, where he combines talents with other laboratories in this area of research, as well as doing volunteer agriculture work with groups outside of the USDA. He has worked for ARS since 1983 and with small-fruit improvement program of the Fruit Laboratory since 1992.

Candice Brown
Biological Science Aid

Candice works with Dr. Freddi Hammerschlag in support of research on molecular approaches to generate small fruits with increased levels of cold tolerance and disease resistance. She is currently an undergraduate student at Howard University with a major in Biology. Current work includes initiating and maintaining strawberry cultivars in tissue culture and collecting samples for extraction of DNA from tissue-culture induced variants of strawberry. Candice has worked with Dr. Hammerschlag since July 2003.

Darlene Butler
Office Automation Assistant

Darlene works with Kendra Jenkins in the main office of the Fruit Laboratory providing support services for FL personnel. Her main responsibilities include processing manuscript journal submissions into the ARIS database, personnel actions, time and attendance, procurement, domestic travel and working with spreadsheets in Excel. She has been with the Fruit Laboratory since 2003.

Julia Cabrera-Woscek
Biological Science Laboratory Technician

Julia works with Dr. Hartung on citrus pathology. Her durties include isolation and cultivation of *Xylella fastidiosa*, and PCR-based assays for exotic citrus pathogens including *Xylella* (citrus variegated chlorosis), *Xanthomonas* (citrus canker) and *Liberobacter* (citrus greening). She also maintains extensive inventory records for our collection of pathogens and other biological materials. Julia has a Bachelor's degree in Biology from the University of Central Florida in Orlando, FL and has worked in the citrus program since 2001.

Tim Chartier
Biological Science Aid

Tim has worked with Suzanne Hurtt in the Plant Germplasm Quarantine Office since 2003, assisting in all aspects of the Potato and Sweetpotato Programs. He attends the University of Maryland, College Park, and is working towards a B.S. degree in Agricultural Science, with an anticipated completion in 2005.

Xiaoling Cao
Visiting Scientist

Ms. Cao, from the Shaanxi Fruit Crops Research Center, Xian, P.R. China worked with Dr. Hammerschlag from 1996 through 2000. Research included developing protocols for high frequency regeneration and transformation of commercially important blueberry cultivars and introducing cold tolerance genes into blueberry via *Agrobacterium*-mediated gene transfer. Ms. Cao has gone on to obtain an advanced degree in computer technologies.

Gareth Davis
Biological Science Lab Technician

Gareth is responsible for virus-eradication therapy and *in vitro* handling of fruit crops in the Plant Germplasm Quarantine Office, Tissue Culture Lab, currently under the supervision of Ray Mock. He treats infected imported germplasm with combinations of heat and chemotherapy, and meristem extraction to eliminate pathogens. Recent personnel departures from the PGQO have necessitated that Gareth also acts as a resource for, and assists in the maintenance of sugarcane

(*Saccharum*), potato (*Solanum*), and sweet potato (*Ipomoea*). He also provides technical supervision of the two student employees, Gregory Anderson and Margaret Smither. Gareth is a 1997 graduate of Cornell University, with a B.S. degree in Horticultural Science. He received his MS in Plant Science in 1999 from the University of Delaware, and joined the PGQO in 2000. His expertise in computer software systems is a benefit to many colleagues in the PGQO.

John Deyorio
Gardener

John has worked in the Plant Germplasm Quarantine Office since 1991. He works with Dr. Gary Kinard supporting the daily operations of all the PGQO programs by helping with maintenance, sanitation, and care of plants in the greenhouse, screenhouse, and orchard.

Anik Luke Dhanaraj
Visiting Scientist

Dr. Dhanaraj graduated from the University of Agricultural Sciences, Bangalore, India and has been a visiting scientist with Dr. Rowland since March 2002. He is involved in the genomic project to study cold hardiness in blueberry using EST markers and has identified several cold responsive transcripts. His research also includes use of microarrays to study expression levels of various blueberry transcripts with cold.

Kevin Donnelly
Agricultural Science Research Technician

Kevin works with Ray Mock and manages the technical operation of the grass, small fruit, woody ornamental, and tropical crop quarantine pathogen-testing programs. He also processes some post-entry genera involving crop grow-outs or genetic crosses to produce seeds for release. In 1988 he earned a B.S. degree in Botany from the University of Maryland, and followed with post-graduate work in Agronomy and Virology. Kevin joined the Plant Germplasm Quarantine Office in 1991 bringing skills in propagation and growth of a wide variety of plant genera, and has developed expertise in pathogen-testing techniques including graft and mechanical inoculations and electron microscopy. Kevin also conducts inventories, enters test data, and prepares information to be used in various reports.

Phil Edmonds
Agricultural Science Research Technician

Phil works with Dr. Black in small fruit production research. His duties include maintaining Dr. Black's field and greenhouse experiments for strawberry and blueberry, and responsibility for daily oversight of seasonal and student employees. Phil also works for the Plant Science Institute as a pesticide applicator in the PSI greenhouses. He has developed integrated pest management strategies for the greenhouses, and consults with the greenhouse manager on IPM issues. Phil joined the Fruit Laboratory in 1983, working first for the strawberry breeding program and then as lead field technician on apple research for many years.

John Enns
Horticulturist

John works with Dr. Kim Lewers in the small fruit-breeding program. He received his B.S. degree in Horticulture from North Dakota State University in 1977 and joined the strawberry breeding program at Beltsville in 1978. John received an associate's degree in Computer Systems and Analysis from Prince Georges Community College 1989 and has taken nine graduate level credits in statistics at the University of Maryland. His current duties include supervising the controlled berry pollinations, managing all field plots and experiments, and collection of data from all non-harvested plot evaluations, replicated harvests, and other experiments. John subsequently organizes the data and completes the data analysis and assists with data analysis and preparation of various reports and manuscripts.

Emanuel Fogle
Gardener

Emanuel worked with Andrew Wilson in the Plant Germplasm Quarantine Office providing support services and caring for plants in the orchards, greenhouses and screenhouses at the Building 580 complex. He has worked for ARS since 1967 and has recently retired.

Ingrid Fordham
Horticulturist

Ingrid works as a support scientist for Dr. Black. She oversees work on potential alternative fruit crops including *Elaeagnus umbellata* (Autumn Olive or Autumnberry). She discovered the high lycopene content in *E. umbellata* fruit, leading to several publications and research collaborations with scientists throughout the United States. She is currently responsible for an *E. umbellata* germplasm collection and related field experiments. Ingrid also oversees laboratory projects including Carbon-Nitrogen analysis of plant tissue and soil samples. She received a B.S. in Horticulture from the University of Maryland in 1981, joining the Fruit Laboratory in 1980. Until 1999, Ingrid worked for Dr. Richard Zimmerman (retired) conducting plant tissue culture experiments with apple, blueberry, rhododendron, *Rubus*, and *Erythroxylum*.

Sandra Garcés
Visiting Scientist

Ms. Garcés, from Pontifica Universidad Católica del Ecuador, Quito, Ecuador, worked with Dr. Hammerschlag from 1999 through 2000. Research included developing a tissue culture screening system to evaluate strawberry cultivars and tissue culture variants for resistance in strawberry to *Colletotrichum acutatum*. Ms. Garcés is currently pursuing graduate studies and is a farm manager in Ecuador.

Sam Garrett
Agricultural Science Research Technician

Sam works with Dr. Lewers in the small fruit breeding program and has been in this program at Beltsville for 12 years. He received his B.S. degree in Biology from the University of Maryland Eastern Shore in 1970. Sam is responsible for the production and maintenance of experimental plants in the greenhouse including seedlings for the annual red stele screening, plant materials for field experiments, annual yield and observation trials, including maintaining inventories and labeling of all plant materials in the greenhouses. Sam is also responsible for the maintenance of the greenhouse and head house physical structures, shipping plant materials to collaborators and other requesting agencies and individuals.

Jeremy Goetz
Biological Science Laboratory Technician

Mr. Goetz worked with Dr. Slovin from January 2001 to July 2003. His duties included greenhouse and growth chamber maintenance, experiment set up and data acquisition. In the laboratory he extracted DNA and proteins, and used PCR and immunoblotting to analyze expression of stress response proteins in strawberry. He resigned his position to pursue graduate studies in ecology.

David Goodkind
Gardener

David works with Dr. Gary Kinard in support of the pome quarantine program. He performs grafting techniques to propagate foreign germplasm accessions and to test for pathogens of quarantine significance. David also assists with daily operations in the greenhouse, screenhouse, and orchard such as potting, watering, and pruning. He is a graduate of the University of Maryland with a BA degree in history and has been employed with the USDA since 1966.

Amanda Hammann
Biological Science Aid

Amanda works with Dr. Slovin to help maintain plants in the greenhouse and growth chambers, and is learning tissue culture and molecular biology techniques to support the work on stress response proteins in strawberry. She is an undergraduate student at the University of Maryland, College Park, with an interest in microbiology. She has worked with Dr. Slovin since April 2003.

Qi Huang
Visiting Scientist

Dr. Huang, who completed her Ph.D. at the University of Wisconsin, was a post-doctoral research associate with Dr. Hartung from August, 1999 through August, 2001. Her research involved completing a characterization of the Citrus Yellow Mosaic BADNA virus from India

and determining its relationship to superficially similar BADNA viruses from sugarcane. She is also interested in developing this double-stranded DNA virus into a tool for plant biotechnology. She is now a staff scientist in the Floral and Nursery Plants Research Unit of the U.S. National Arboretum, USDA ARS in Beltsville.

Kendra Jenkins
Support Services Assistant

Kendra joined the group in April, 1999. She is responsible for the administrative management of the Fruit Laboratory office. She also has a major role in the preparation of the annual budget package. In 1998, in her previous position, Kendra was named Administrative Support Employee of the Year for the Plant Sciences Institute.

Hongjun Jiao
Visiting Scientist

Ms. Jiao, from Guangxi Agricultural University, Nanning, Guangxi, P.R. China, was a visiting scientist with Dr. Wang from September 1999 through September, 2000. Her research included the elucidation of oxygen radical scavenging systems related to phytonutrient contents in small fruits.

Sue Kim
Biological Science Aid

Sue works with Dr. Wang in the antioxidant program. She is a senior student at University of Maryland majoring in Biological Science and works part time in laboratory for determining fruit quality and antioxidant activity of berry crops. She joined the Laboratory in October 2003.

Tom Kim
Agricultural Science Research Technician

Tom works with Ray Mock in the Plant Germplasm Quarantine Office and manages the technical operation of the stone fruit quarantine pathogen-testing program. In 1976 he earned a B.S. degree in Horticulture from Kon-Kuk University, Seoul, Korea and has completed post-graduate work also specializing in Horticulture. Tom brought a well-rounded knowledge of plant growth to the PGQO and continues to acquire skills in stone fruit tree maintenance. He performs a variety of pathogen-testing operations including graft and mechanical transmissions, and molecular detection techniques, such as nucleic acid extractions and PCR, and viroid hybridizations. Tom also maintains inventories, performs data entry, and prepares data to be included in reports. He has been working with the USDA-ARS since 1989 and with the PGQO since Dec. 2000.

Adrienne Labega
Agricultural Science Research Technician

Adrienne works with Dr. Rowland and Dr. Black and has been with the Fruit Laboratory since 1991. She has a B.A. in Elementary Education from the University of the Incarnate Word and an M.Agr. from Texas A & M University. Her responsibilities include data collection, entry and analysis, sample preparation, and other work in support of the blueberry mapping project and development of sustainable production systems for small fruit crops.

AeKyung Lee
Visiting Scientist

Dr. Lee, from the Laboratory of Floriculture and Plant Physiology, School of Bio-Resources Science, Dankook University, Cheonan, Korea, was a visiting scientist with Dr. Slovin from April 2000 to August 2001. Her research used polyacrylamide gel electrophoresis and immunoblotting to study stress response proteins in recalcitrant seeds.

Wenbin Li
Visiting Scientist

Dr. Li has a Master's degree in Horticulture from Huazhong Agricultural University in Wuhan, People's Republic of China and a Ph.D. in Plant Sciences from the University of Sao Paulo. He has worked in Dr. Hartung's laboratory since April of 2001 on the interactions of *Xylella fastidiosa* with different plant hosts, including grapevine, periwinkle and citrus. He has demonstrated that the sweet orange strain of *X. fastidiosa* can also infect and cause disease in grapevine, and has made the noteworthy discovery that the sweet orange strain of *X. fastidosa* colonizes seed extensively and can be transmitted through seed to seedlings. This work was done in collaboration with researchers at his former employer, Fundecitrus, of Sao Paulo, Brazil and the University of Sao Paulo. He is currently studying the interaction of marked mutants of the bacterium with their plant hosts using confocal microscopy and quantitative PCR.

Crindi Loschinkohl
Biological Science Technician

Crindi works with Suzanne Hurtt as the crop specialist for the *Solanum* (tuber-bearing potato) and *Ipomoea* (sweet potato) quarantine programs in the Plant Germplasm Quarantine Office of the Fruit Laboratory. Crindi received her M.S. degree in Plant Pathology from the Ohio State University in 2000 and a B.S. degree in Horticulture Science from The University of Maryland in 1997. She joined PGQO in 2000 and since then has managed the daily operations for the growth, indexing, and release from quarantine of potato and sweet potato.

Robert Martin
Agricultural Science Research Technician

Rob works with Dr. Ehlenfeldt in the blueberry breeding program. Rob earned his B.S. degree in Environmental Studies from the Richard Stockton College of N.J. in 1999. He began working with the U.S.D.A. as a technician for Rutgers University at the Philip E. Marucci Blueberry & Cranberry Research Center in 1999 before taking his current U.S.D.A. position in 2001. As a technician for the blueberry breeding program, his duties include data collection and analysis, as well as field and greenhouse care and maintenance. He also compiles and arranges yield reports and acts as safety officer for the U.S.D.A. facilities at the Philip E. Marucci Center.

Andrea Murphy
Biological Science Laboratory Technician

Andrea began working with Dr. Slovin in January 2004 to study stress response proteins in strawberry. Her duties include laboratory, greenhouse, and growth chamber maintenance, as well as experiment design, setup, data acquisition, and analysis. In the laboratory she is responsible for tissue culture and plant transformation, as well as extraction and analysis of proteins, DNA, and RNA. Andrea received her BS in Horticulture with emphasis in genetics in 1999, and her MS in Plant Genetics with an emphasis in plant pathology in 2001.

Elizabeth Ogden
Agricultural Science Research Technician

Elizabeth works with Dr. Rowland providing laboratory, greenhouse and field support for the blueberry cold hardiness and dormancy research program. She has a B.S. degree in Horticulture from the University of Maryland. She has worked for the Fruit Laboratory since 1984. Current work includes maintaining greenhouse and field plants of the blueberry mapping population, evaluating the population for chilling requirement and cold hardiness, further saturating the genetic linkage maps of blueberry with molecular markers, and conducting deacclimation studies of blueberry genotypes.

Tulin Olchum
Visiting Scientist

Dr. Olchum, then a graduate student from the Department of Biology, George Washington University, Washington, DC, was a visiting scientist with Dr. Slovin from June through August 2001. She visited the lab to learn electrophoresis and protein purification procedures.

Tina Gouin Paul
Horticulturist

Tina has worked in the citrus quarantine facility at BARC since 1989 as an employee of the University of Florida assigned to the plant collection at Beltsville. When the new CRIS project was created to stabilize the funding for the collection, Tina was hired as a support scientist in the laboratory in 1999. She maintains the citrus plants in the greenhouse and cooperates extensively with the many visitors to the facility. She also designed and maintains the home page for the Fruit Laboratory and is the support person for the poster printer. Tina has both a Bachelor's and a Master's degree in Horticulture from the University of Maryland.

Ernalyn Peralta
Biological Science Aid

Ernalyn works with Dr. Freddi Hammerschlag in support of research on molecular approaches to generate small fruits with increased levels of cold tolerance and disease resistance. She is currently an undergraduate at the University of Maryland, College Park, as a Biological Resources Engineering major. Current work includes initiating and maintaining blueberry and apple cultivars in tissue culture and in preparing strawberry tissue cultures for in vitro screening for resistance to *Colletotrichum acutatum.* Ernalyn has worked with Dr. Hammerschlag since January 2004.

Xiaoting Qin
Visiting Scientist

Dr. Qin, from the Chinese Academy of Agricultural Sciences, Beijing, was a visiting scientist with Dr. Hartung from 1997 through 2001. Her research was centered on developing tools and knowledge needed for the genetic analysis of sweet orange strains of *Xylella fastidiosa*, now a 'select agent'. She characterized the population structure of these strains isolated from citrus and coffee in Brazil and then developed a quantitative and real-time PCR based assay to detect them. She also introduced green fluorescent protein labels into marked mutations in the bacterial genome and developed both a transformation protocol and shuttle vector for use genetic studies. The marked strains are currently being used for in planta studies. Dr. Qin is now at the University of Georgia, Athens.

Kate Rappaport
Agricultural Science Research Technician

Kate works with Dr. Lewers in the small fruit breeding program and has been in this program at Beltsville since 1991. She received her B.A. degree in Foreign Languages (Spanish) from Washington College in 1983. Kate also has an Associate Degree in Applied Agriculture from the University of Maryland in 1986. Kate is responsible for all aspects of the strawberry virus detection and eradication procedures associated with the breeding program. She currently uses meristem dissection, grafting indicator plants, heat treatments, and ELISA based virus detection. She plans to initiate RT-PCR detection techniques. Kate is responsible for genomic DNA

extractions. She conducts and documents the molecular marker experiments in the Lab. She is also responsible for ordering lab supplies and equipment, maintaining inventories and safety compliance.

Stephanie Ray
Biological Science Laboratory Technician

Stephanie works with Dr. Freddi Hammerschlag in support of research on molecular approaches to generate small fruits with increased levels of cold tolerance and disease resistance. She received her B.S. degree in Animal Science, 1991, M.S. degree in Animal Science and Biotechnology, 1999 from Tuskegee University, Tuskegee, AL. Current work includes maintaining the strawberry and blueberry, sceening strawberry tissue-culture induced variants for disease resistance, and developing protocols for high frequency regeneration and transformation of strawberry and blueberry. Stephanie has worked with Dr. Hammerschlag since 1997.

James Rhodes
Gardener

James worked with Andrew Wilson in the Plant Germplasm Quarantine Office providing support services and caring for plants in the orchards, greenhouses and screenhouses at the Building 580 complex. He has worked for ARS since 1963 and has been with PGQO since 1990 and recently retired.

Tiara Ross
Biological Science Aid

Tiara Ross is a senior at the University of Maryland, College Park, majoring in Psychology. She is a native of Baltmore, MD. She has worked in the citrus quarantine facility at BARC since 2002 as an employee of the University of Florida assigned to the plant collection at Beltsville.

Margaret Smither
Biological Science Aid

Margaret works with Gareth Davis in the Plant Germplasm Quarantine Office. She assists in operations of the Tissue Culture Lab, starting with PGQO in January 2004. She is an undergraduate at the University of Maryland, College Park, studying for a B.S. degree in General Biology, with an anticipated completion in 2005.

Matthew Stevens
Visiting Scientist

Mr. Stevens is a M.S. student in the Natural Resource Science and Landscape Architecture Department at the University of Maryland. Since 2002, he has been working with Dr. Black and Dr. John Lea-Cox from the University of Maryland on a grant-funded cooperative project to evaluate the economics and environmental impacts of three cold-climate strawberry production systems. The project will be completed in the Fall of 2004.

Paulo Teixeira Lacava
Visiting Scientist

Paulo is a student at the University of São Paulo, Piricicaba, São Paulo, Brazil working on his Ph. D. degree in Plant Pathology. His thesis topic is on the interactions between *Xylella fastidiosa*, endophytic bacteria and citrus variegated chlorosis disease. He is currently working in Dr. Hartung's laboratory completing a portion of his thesis research. While in the Fruit laboratory he will develop and use quantitative PCR based methods for the simultaneous detection and enumeration of both *Xylella fastidiosa* and specific endophytic bacteria in samples from diseased plants. These methods are needed to test the hypothesis that specific endophytic bacteria can either promote or inhibit the development of Citrus variegated chlorosis disease.

Roy Turner
Agricultural Science Research Technician

Roy works with Suzanne Hurtt as the crop specialist for the *Saccharum* (sugarcane) quarantine program in the Plant Germplasm Quarantine Office of the Fruit Laboratory. Roy received his B.S. degree in Soil Science from the University of Maryland in 1986. Since joining the PGQO staff in 1989, he has managed the daily activities associated with growth, indexing, and release from quarantine of sugarcane and related genera. He manages the greenhouse and laboratory facilities and conducts immunological, molecular, and bioassays for exotic pathogens of sugarcane. Recently, Roy has taken on new duties assisting personnel in the Fruit Laboratory with computer and software configuration, maintenance and troubleshooting.

Katreena Whitted
Biological Science Aid

Katreena works with Ray Mock in the Plant Germplasm Quarantine Office primarily in the stone fruit quarantine program, with some work in the small fruit/grass quarantine programs. Starting with PGQO in 2002, Katreena is currently a senior at the University of Maryland, College Park working towards a B.S. degree in Biological Sciences.

Andrew Wilson
Agricultural Science Research Technician

Andrew works with Gary Kinard in support of the pome quarantine program. He performs propagation and biological indexing of pome germplasm accessions in both the greenhouse and in the orchard. He is responsible for the daily management of the apple, pear, and quince orchards and accessions maintained in the screenhouses. Andrew also helps to maintain electronic records for the pome program. He received a BA degree in economics from Trinity College and an MS in entomology from the University of Delaware and joined PGQO in June 2003.

Zhanhui Xu
Visiting Scientist

Dr. Xu, from Chinese Academy of Science, China, was a visiting scientist with Dr. Wang from October 2001 through September 2002. His research included developing the analytical methods for measuring antioxidant capacity of Autumn Oliver fruit.

Wei Zheng
Visiting Scientist

Dr. Zheng, from the Institute of Environmental Science, Zhejiang University, China, was a visiting scientist with Dr. Wang from October 2000 through September 2001. His research included evaluating the effect of genotypes and cultural conditions on antioxidant capacity of flavonoids and phenolic content in berry crops.

Changhe Zhou
Visiting Scientist

Dr. Changhe Zhou came to the Fruit Laboratory from the Huazhong Agricultural University in Wuhan, People's Republic of China, where he was Associate professor of Horticulture. He worked in the citrus program at Beltsville from May of 2001 through May of 2002. While at Beltsville he refined real time and quantitative PCR assays for *Xylella fastidiosa* and characterized the interactions between *X. fastidiosa* and various plant hosts. He is now at West Virginia University.

How to Contact the Fruit Laboratory

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The Laboratory Website is: http://www.barc.usda.gov/psi/fl/fl.htm

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Definitions of Some Terms, Abbreviations & Acronyms Used in ARS

ARS: ***Agricultural Research Service.*** An agency in Research, Education, and Economics of USDA. ARS has approximately 8,057 employees, including about 953 senior scientists. The Agency conducts research at 104 locations in the U.S. ARS is led by an Administrator and is divided geographically into eight Areas which are led by Area Directors.

BA: ***Beltsville Area.*** The Beltsville Area includes the Beltsville Agricultural Research Center, the U.S. National Arboretum and the Glenn Date Plant Distribution Station. The Beltsville Area, at 6,600 acres, is the smallest Area geographically but the largest in terms of personnel and budget. About 1,567 employees, including about 462 scientists, work in the BA.

NPS: ***National Program Staff.*** Members are called National Program Leaders and each is a subject matter specialist. NPS serves the Administrator of ARS in developing and coordinating research plans and strategies in a national basis. NPS sets national program directions, establishes priorities, allocates resources and acts as a clearing house for decision making. Considerable interaction between Area managers and NPS is required to fulfill their respective roles.

Institute/Centers: The Beltsville Agricultural Research Center is composed of four *Institutes or Centers:* the ***Plant Sciences Institute***, the ***Animal and Natural Resources Institute***, the ***Beltsville Human Nutrition Research Center*** and the ***U.S. National Arboretum***.

Laboratories: ***Laboratories*** are units located in the Institutes/Centers. Laboratories are led, both scientifically and administratively, by Research Leaders. Typically, a Laboratory is comprised of 8-10 scientists, a scientific and clerical support staff and several temporary student and postdoctoral employees. The program and mission of a Laboratory of this size must obviously be limited. In reviewing a Laboratory, bear in mind that what appear to br discipline or program gaps are often filled by collaboration with other Laboratories in the BA or elsewhere.

CRIS: ***Current Research Information System.*** This is an electronic system for the filing and retrieval of information about individual agricultural research projects. In ARS, the terms "CRIS Work Unit" or the acronym "CRIS" are used synonymously with "research project" or "project". New projects are planned in coordination with NPS and are subjected to peer review. The normal life of a project in ARS is 3 to 5 years.

OSQR: ***Office Scientific Quality Review.*** The Peer Review process conducted by the OSQR involves independent and expert scientific peer review of ARS project plans. This is a critical component of research planning. In this way, OSQR contributes to the National Programs focus on quality of ARS research.

SY: ***Scientist Year.*** This is the effort of a research scientist for one year. Fractional efforts (e.g., 0.5 SY) in a given project are possible when a scientist works in more than one project during the course of a fiscal year. The term is also used in ARS as a synonym for a research scientist (Category 1) or a service scientist (Category 4) who performs work involving service to the public, other government agencies or other ARS programs.

Other Kinds of Scientific Personnel: Research scientists are responsible for all phases of research. ARS also employs research associates (postdocs), support scientists (who have responsibility for some portion of a project), technicians and students.

RPES: ***Research Position Evaluation System.*** Provides for review of ARS Category 1 positions on a cyclical basis to assure classification accuracy. The RPES is based on the "person-in-the-job" concept. Under this concept, research scientists have open-ended promotion potential based on their personal research and leadership accomplishments, which can change the complexity and responsibility of their positions. The RPES applies **only** to ARS Category 1 research positions. Other professional scientific positions are evaluated by application of appropriate U.S. Office of Personnel Management (OPM) classification standards.

AM: ***Administrative Management.*** This branch of ARS manages support activities, such as procurement, facilities, fiscal allocations and personnel operations at all levels in ARS.

Commonly Used Acronyms of USDA, REE, and ARS

AA	Associate Administrator
AAD	Associate Area Director
AAO	Area Administrative Officer
ABFO	Area Budget and Fiscal Officer
AC	Administrator's Council
AC	Accounting Code
ACS	Area Computer Specialist
AD	Area Director
ADA	Associate Deputy Administrator
ADAAM	Associate Deputy Administrator, Administrative Management
ADO	Authorized Departmental Officer
ADP	Automated Data Processing
ADODR	Authorized Departmental Officer's Designated Representative
AES	Agricultural Experiment Station
AFM	Administrative and Financial Management
AL	Annual Leave
AM	Administrative Management
AO	Administrative Officer
AOD	Administrative Operations Division
APHIS	Animal and Plant Health Inspection Service
APMO	Area Property Management Officer
APO	Accountable Property Officer
ARMP	Annual Resource Management Plan
ARMPS	Annual Resource Management Planning System
ARMS	ARS Resource Management System
ARS	Agricultural Research Service
ARS-CMU	ARS Correspondence Management Unit
ARS-LS	ARS Legislative Staff
ARS-OA	ARS Office of Administrator
ARSITS	Agricultural Research Service Invention Tracking System
ASB	Accounting Services Branch
ASHM	Area Safety and Health Manager
ATR	Agriculture Travel Regulations
AUO	Area Utilization Officer
AWOL	Absent Without Leave
BA	Beltsville Area
BARC	Beltsville Agricultural Research Center
B&F	Budget and Fiscal
BFSB	Budget and Fiscal Services Branch, FMD
BOC	Budget Object Class
BPMS	Budget & Program Management Staff
BSO	Biological Safety Officer
CAA	Clean Air Act
CAD	Contracting and Assistance Division
CD	Center Director
CDSD	Communications and Data Services Division

CDSO	Collateral Duty Safety Officer
CEP	Career Enhancement Program
CEPS	Cluster Environmental Protection Specialist
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFC	Combined Federal Campaign
CFR	Code of Federal Regulations
CG	Comptroller General
CMCO	Classified Material Control Officer
COLA	Cost of Living Allowance
COP	Continuation of Pay
COR	Contracting Officer's Representative
CR	Civil Rights
CRAS	CRIS Resource Allocation Schedule
CRIS	Current Research Information System
CS	Contract Specialist
CSRA	Civil Service Reform Act
CSREES	Cooperative State Research, Education and Extension Service
CSRS	Civil Service Retirement System
CWA	Clean Water Act
DA	Deputy Administrator
DAAM	Deputy Administrator, Administrative Management
DAEA	Designated Area Ethics Advisor
DEMO	USDA Demonstration Project
DM	Department Manual
DOD	Department of Defense
DOJ	Department of Justice
DPM	Department Personnel Manual
DR	Department Regulation
EAD	Extramural Agreements Division
EAP	Employee Assistance Program
EAS	Employee Appeals Staff
EEO	Equal Employment Opportunity
EEOC	Equal Employment Opportunity Counselor
EEOO	Equal Employment Opportunity Officer
EO	Executive Order
EOD	Enter on Duty
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ERC	Equipment Review Committee
ERRC	Eastern Regional Research Center
ERS	Economic Research Service
ESB	Extramural Services Branch, Contracting and Assistance Division
FAA	Foreign Agricultural Affairs, FAS
FAO	Food and Agricultural Organization
FAS	Foreign Agricultural Service
FBI	Federal Bureau of Investigation
FCMD	Facilities Construction Management Division
FD	Facilities Division
FDC	Financial Data Code

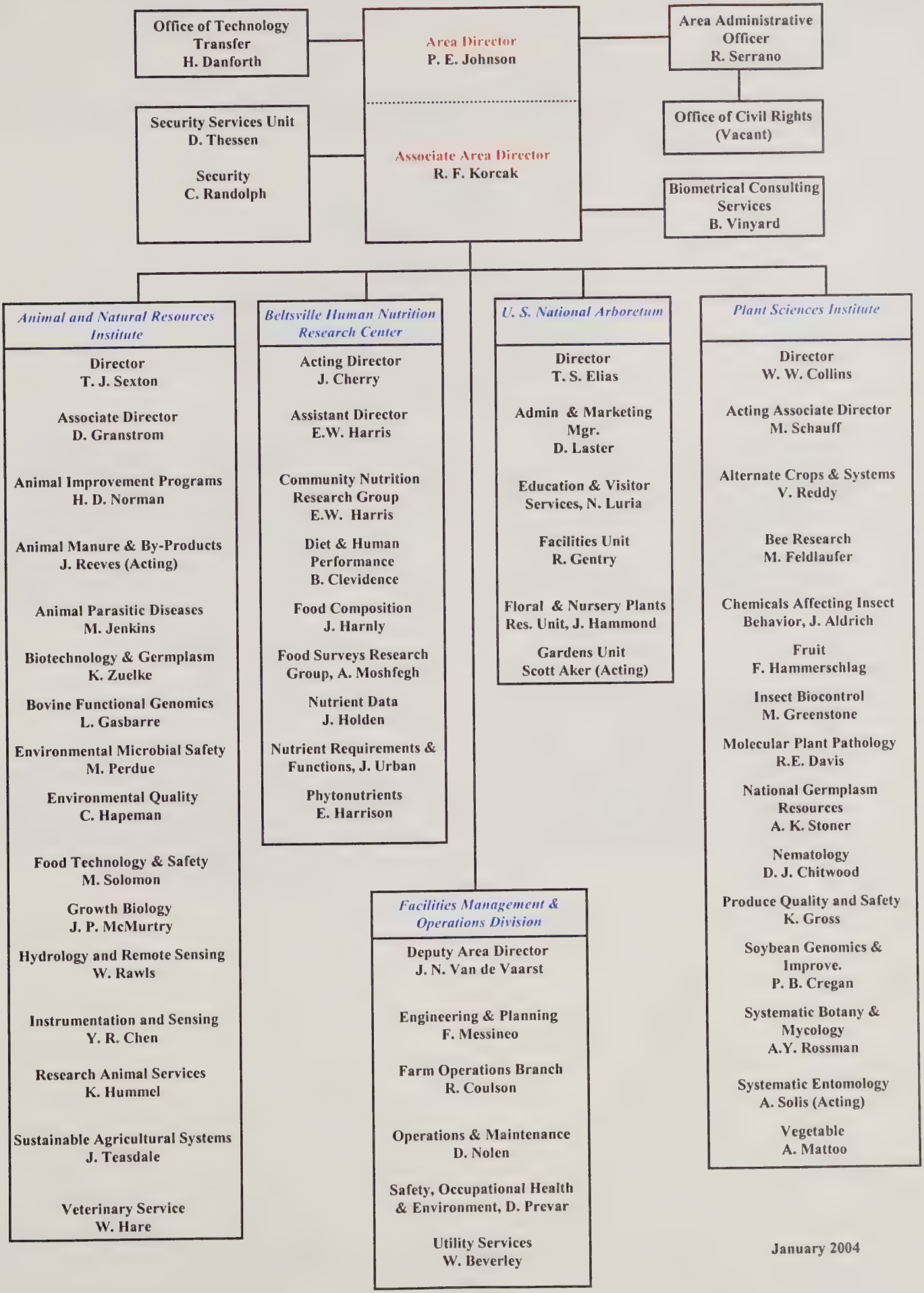
FECA	Federal Employees Compensation Act
FEHB	Federal Employees Health Benefits
FEORP	Federal Equal Opportunity Recruitment Program
FEPA	Federal Employee Pay Act
FEPCA	Federal Employees Pay Comparability Act of 1990
FERS	Federal Employees Retirement System
FLSA	Fair Labor Standards Act
FMD	Financial Management Division
FOIA	Freedom of Information Act
FPL	Full Performance Level
FPM	Federal Personnel Manual
FPMR	Federal Property Management Regulations
FPR	Federal Procurement Regulations
FPRS	Federal Property Resource Services, GSA
FR	Federal Register
FRC	Federal Records Center
FSC	Federal Supply Classification
FSS	Federal Supply Schedule
FT	Full Time Tour of Duty
FTD	Federal Travel Directory
FTE	Full Time Equivalent
FTIS	Foreign Travel Information System
FTR	Federal Travel Regulations
FTS	Federal Telecommunications System
FTTA	Federal Technology Transfer Act
FTU	Foreign Travel Unit, FAS
FWS	Federal Wage System
FY	Fiscal Year
GAMS	Grants and Agreements Management Staff, CAD
GAO	General Accounting Office
GM	GS Employees in the Performance Management and Recognition System
GOV	Government Owned Vehicle
GPO	Government Printing Office
GS	General Schedule
GSA	General Services Administration
GSD	General Services Division
HPRL	High Priority Requirement List
HQS	Headquarters
HRD	Human Resources Division, AFM
HWC	Hazardous Waste Cleanup
IDP	Individual Development Plan
IDR	Indepth Review or Reviewer
IPSC	Indirect Program Support Cost
IR	Invention Report
IRS	Internal Revenue Service
IS	Information Staff
ISTD	Information Systems and Technology Division
ITP	Individual Training Plan
KSA	Knowledge, Skill and Ability

L/A	Letter of Authorization
LAO/LAT	Location Administrative Officer/Technician
LC	Location Coordinator
LD	Laboratory Director
LL	Location Leader
LERB	Labor Employee Relations Branch
LOC	Locations
LOTS	Location Obligation Tracking System
LS	Lead Scientist
LWOP	Leave Without Pay
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MSA	Mid South Area
MSPB	Merit Systems Protection Board
MU	Management Unit
MWA	Midwest Area
NAA	North Atlantic Area
NAL	National Agricultural Library
NARA	National Archives and Records Administration
NARS	National Archives and Records Service
NASS	National Agricultural Statistics Service
NCAUR	National Center for Agricultural Utilization Research
NEPA	National Environmental Policy Act
NFC	National Finance Center
NPA	Northern Plains Area
NPL	National Program Leader
NPS	National Program Staff
NRRC	Northern Regional Research Center
NSB	National Services Branch, PD
NTTC	National Technology Transfer Coordinator
NTE	Not to Exceed
NTIS	National Technology Information Service
OA	Office of the Administrator
OBPA	Office of Budget and Program Analysis, USDA
OCI	Office of Cooperative Interactions
ODS	Official Duty Station
O&F	Office of Operations and Finance
OGC	Office of General Counsel
OGE	Office of Government Ethics
OHMP	Occupational Health Maintenance Program
OICD	Office of International Cooperation and Development
OIG	Office of Inspector General
OMB	Office of Management and Budget
OO	Office of Operations
OP	Office of Personnel
OPM	U.S. Office of Personnel Management
OSEC	Office of Secretary
OSC	Office of Special Counsel
OSHA	Occupational Safety and Health Act/Administration

OSQR	Office of Scientific Quality Review
OTT	Office of Technology Transfer
OWCP	Office of Worker's Compensation
PA	Privacy Act
PA	Patent Advisor
PA	Program Analyst
PAA	Program Analyst Assistant
PAIS	Property Accounting Information System
PAO	Procurement Assistance Officer
PB	Publications Branch
PCMI	President's Council on Management Improvement
PD	Personnel Division
pd	Position Description
PDS	Permanent Duty Station
PFT	Permanent Full Time
PIADC	Plum Island Animal Disease Center
PIP	Performance Improvement Plan
PM	Program Management
PMB	Property Management Branch
PMO	Property Management Officer
PMRS	Performance Management Recognition System
POB	Personnel Operations Branch, PD
POV	Privately Owned Vehicle
P&P	Policies and Procedures
PPPM	Payroll/Personnel Processing Manual
PPMS	Personal Property Management Section
PPSB	Personnel Policy and Systems Branch, PD
PRB	Performance Review Board
PSP	Position Staffing Plan
PT	Part Time Tour of Duty
PTO	Patent and Trademark Office
PVPA	Plant Variety Protection Act
PVPC	Plant Variety Protection Certificate
PWA	Pacific West Area
RA	Research Associate
RAP	Research Apprenticeship Program
RCRA	Resource Conservation and Recovery Act
REE	Research, Education and Economics
RG	Records Group
RGEG	Research Grade Evaluation Guide
RIF	Reduction in Force
RL	Research Leader
R&M	Repair & Maintenance
RMIS	Research Management Information System
RMO	Records Management Officer
RPEC	Research Personnel Evaluation Committee
RPES	Research Position Evaluation System
RSA	Research Support Agreement
RSS	Radiological Safety Staff

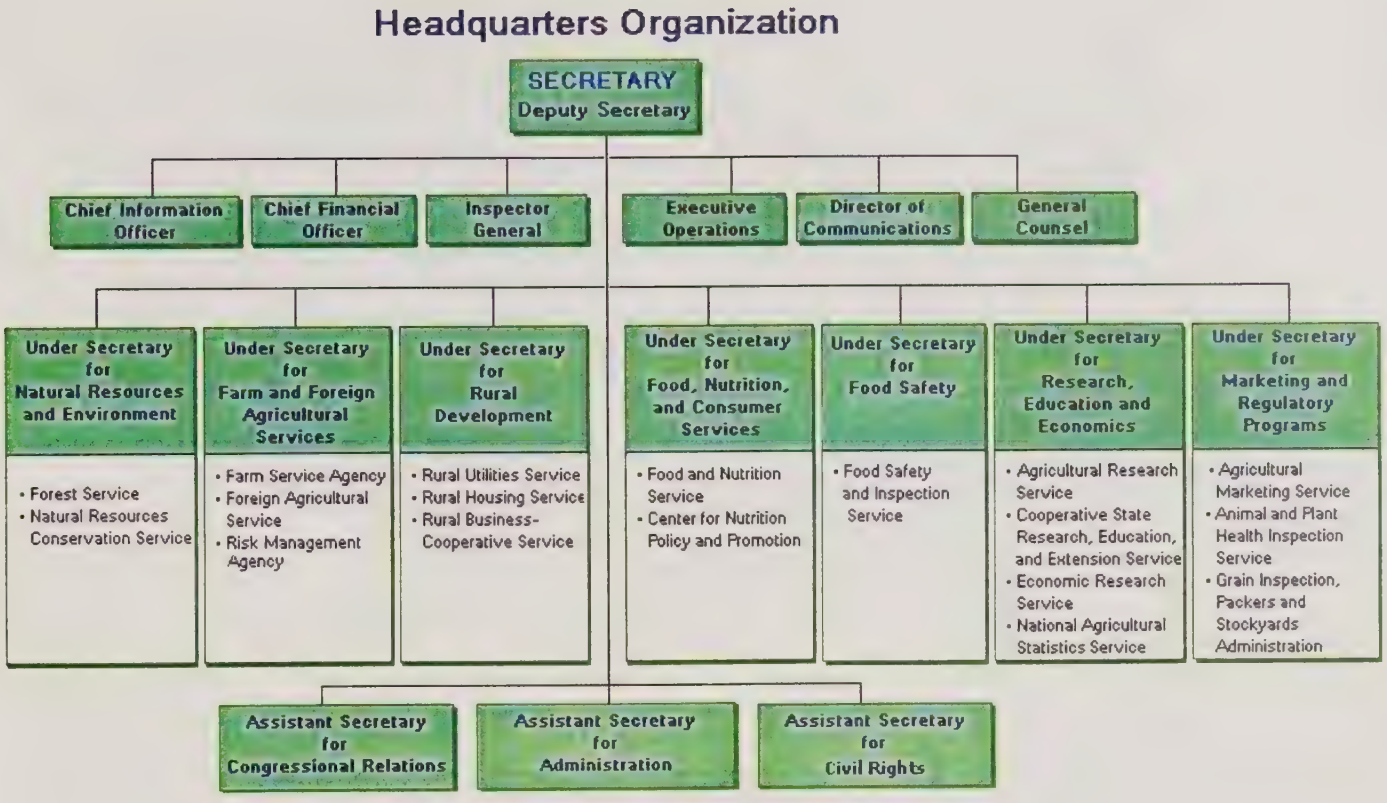
SAA	South Atlantic Area
SES	Senior Executive Service
SF	Standard Form
SGEG	Supervisory Grade-Evaluation Guide
SHEMB	Safety, Health, and Environmental Management Branch
SL	Sick Leave
SOW	Statement of Work
SPA	Southern Plains Area
SPO	Servicing Personnel Office
SPS	Servicing Personnel Specialist
SR	Standard Regulations
SRRC	Southern Regional Research Center
ST	Scientific and Professional Pay Plan
SY	Scientist Year (Category 1 or 4 positions)
T&A	Time and Attendance
TAC	HQ and/or Area Time and Attendance Coordinator
TASSB	Technology Assessment and Support Services Branch
TDY	Temporary Duty
TEKTRAN	Technology Transfer Automated Retrieval System
TEP	Technical Evaluation Panel
TFT	Temporary Full Time
TMC	Travel Management Center
TRAI	Training Information System
TT	Technology Transfer
TY	Travel Year
U.S.C.	United States Code
USDA	United States Department of Agriculture
USPS	United States Postal Service
WG	Wage Grade
WGI	Within-Grade Increase
WNRC	Washington National Records Center
WRRC	Western Regional Research Center

USDA, AGRICULTURAL RESEARCH SERVICE
BELTSVILLE AREA



January 2004

USDA Headquarters Organizational Chart



Updated April 2003

ARS Research Locations

ARS Research Locations